

Sec. 15

SCIENCE

18 August 1961

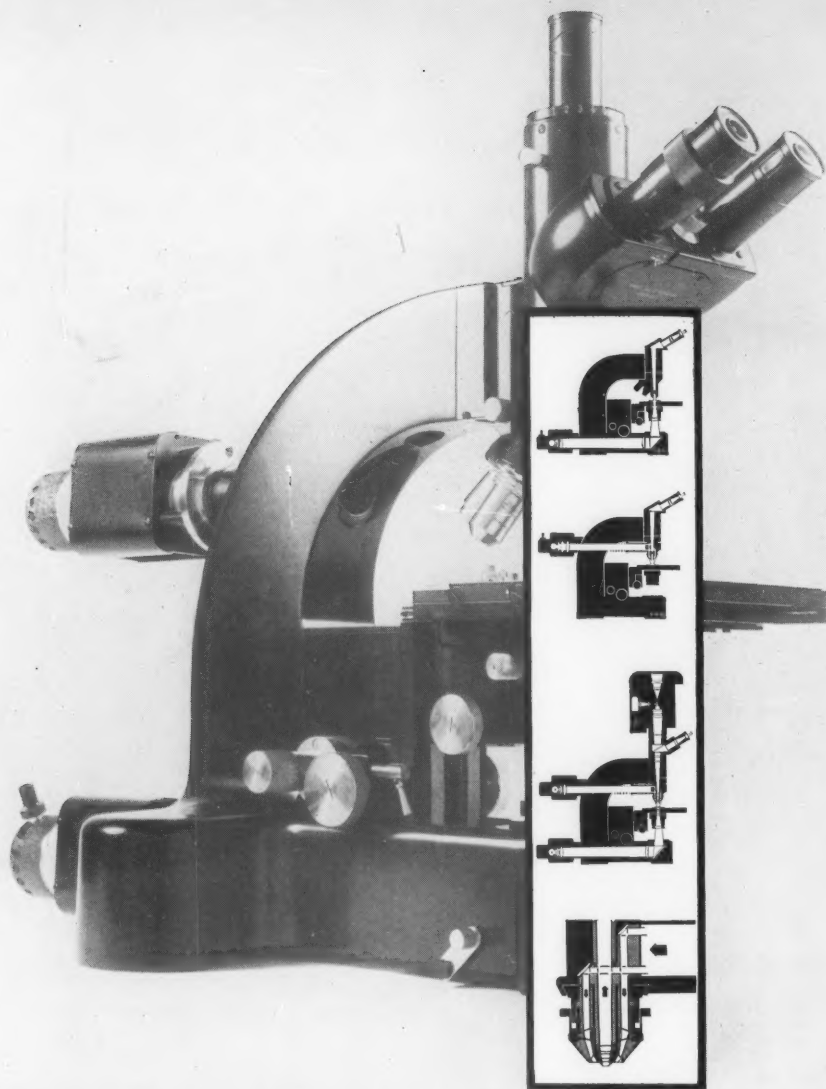
Vol. 134, No. 3477

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

6

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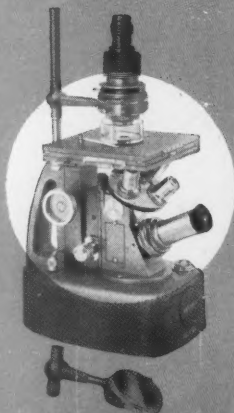
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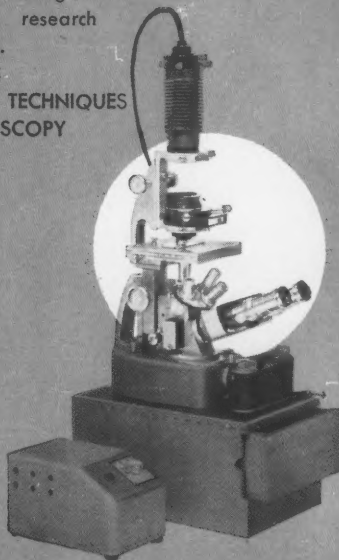
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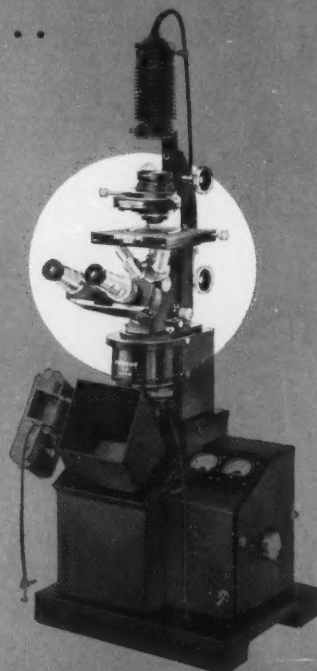
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Cover	NGC 5128 shows one of the most peculiar objects in the sky. Walter Baade and Rudolph Minkowski believe it is two galaxies in collision. From <i>The Hubble Atlas of Galaxies</i> , reviewed on page 464. [Carnegie Institution of Washington]	



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TECHNICAL DATA

Range of measurement —
5 to 5000 units of the fifth decimal of the refractive difference Δn , subdivided according to the length of chamber

Limit of error —
 ± 2 units of the eighth decimal to 2 units of the fifth decimal of the refractive difference Δn , likewise in accordance with the length of the chamber



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- Measurements with higher or lower temperatures

TECHNICAL DATA

Range of measurement —
Refractive index $n_D = 1.3$ to $n_D = 1.7$
Dry substance 0 to 85%

Limit of error —
Refractive index ± 1 to 2 units of the fourth decimal
Dry substance ± 0.1 to 0.2%

FOOD PRODUCTS (SUGAR AND OIL) REFRACTOMETER

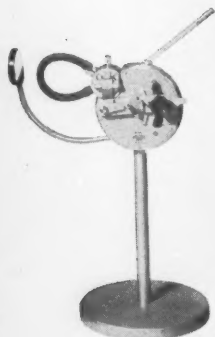
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- Fast, accurate measurements
- Economical use of test material

TECHNICAL DATA

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Refractive index $n_D = 1.300$ to 1.540

Limit of error —
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Refractive index ± 1 to 2 units of the fourth decimal



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TECHNICAL DATA

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Adams Cyclo-Mixers

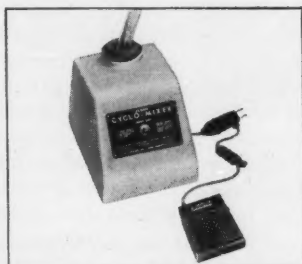
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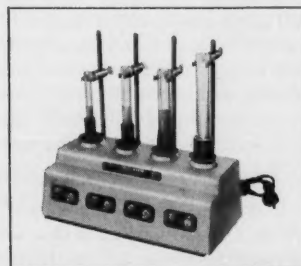
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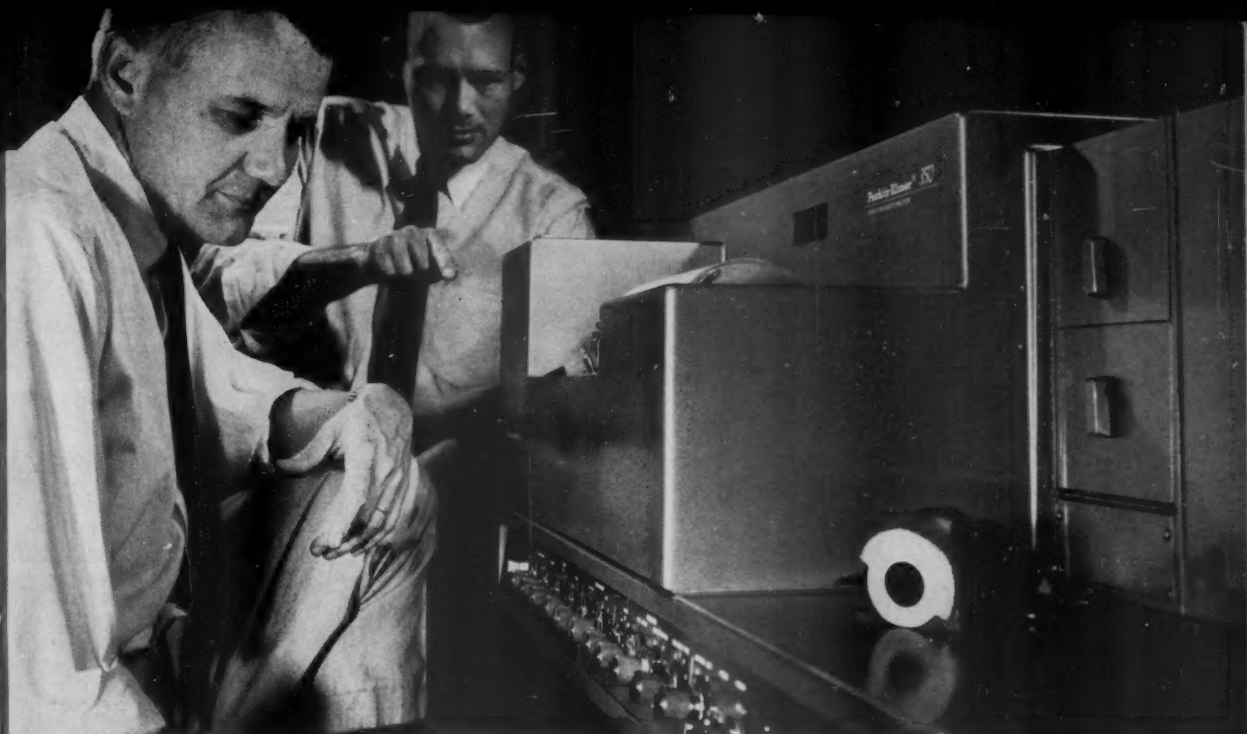
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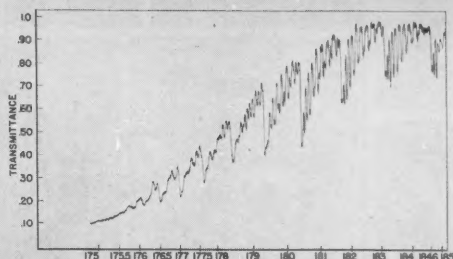
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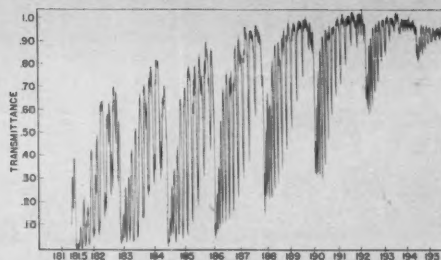
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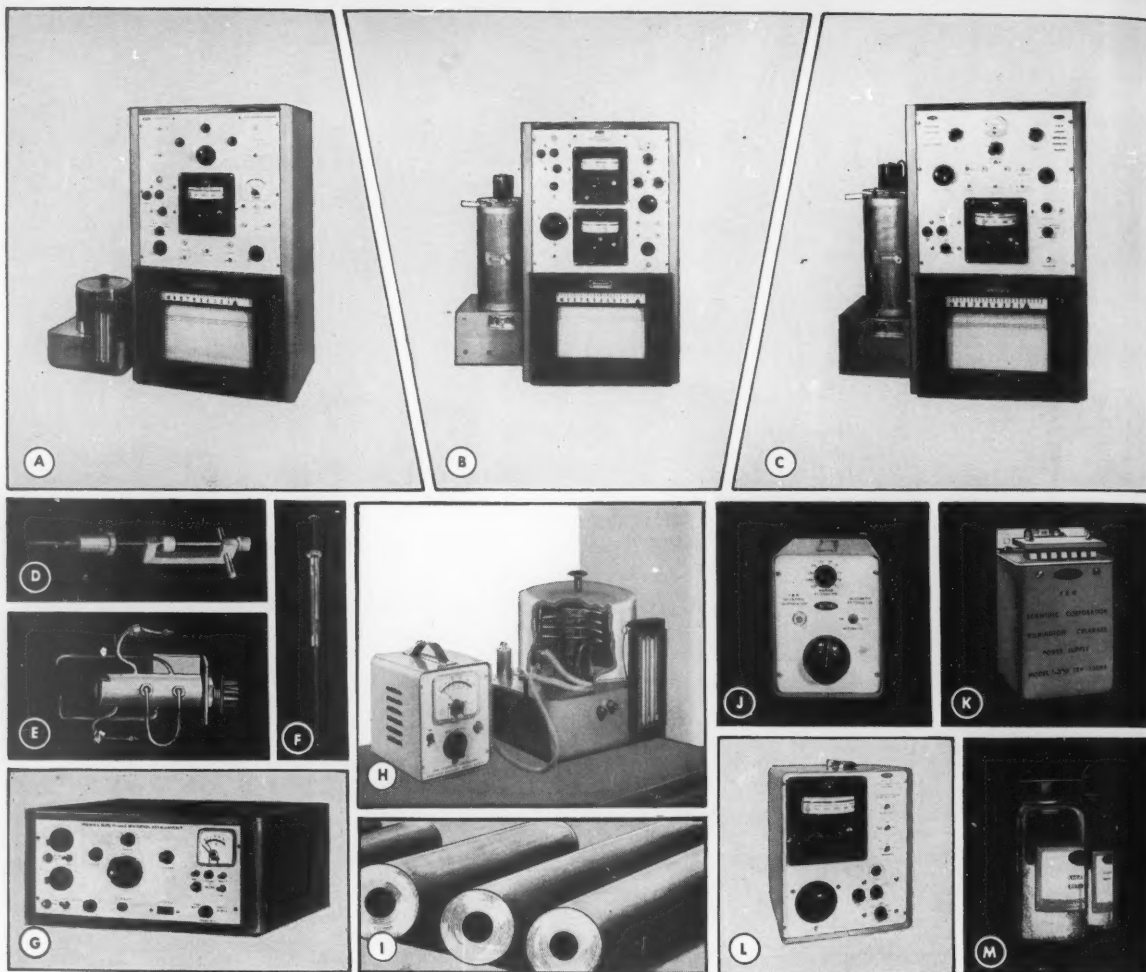
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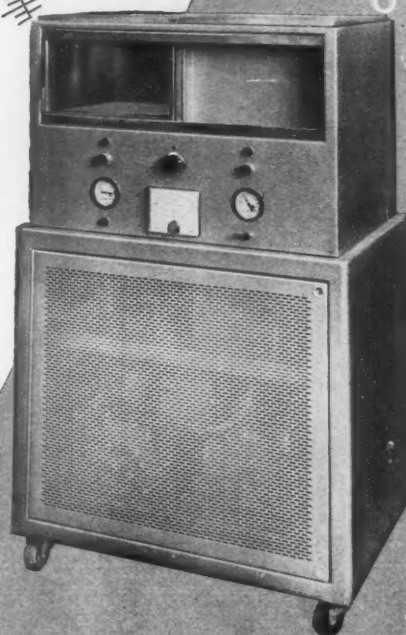
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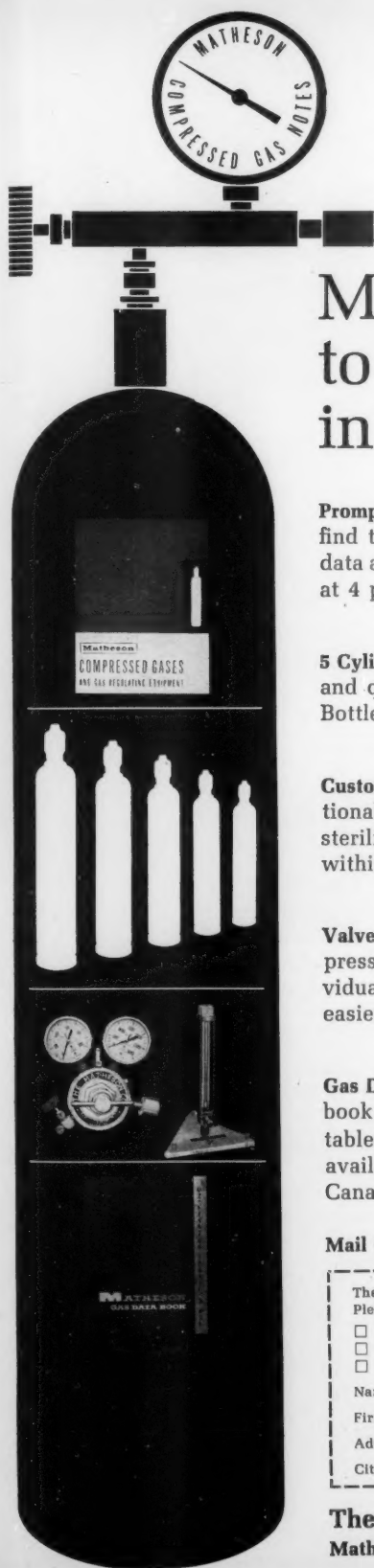
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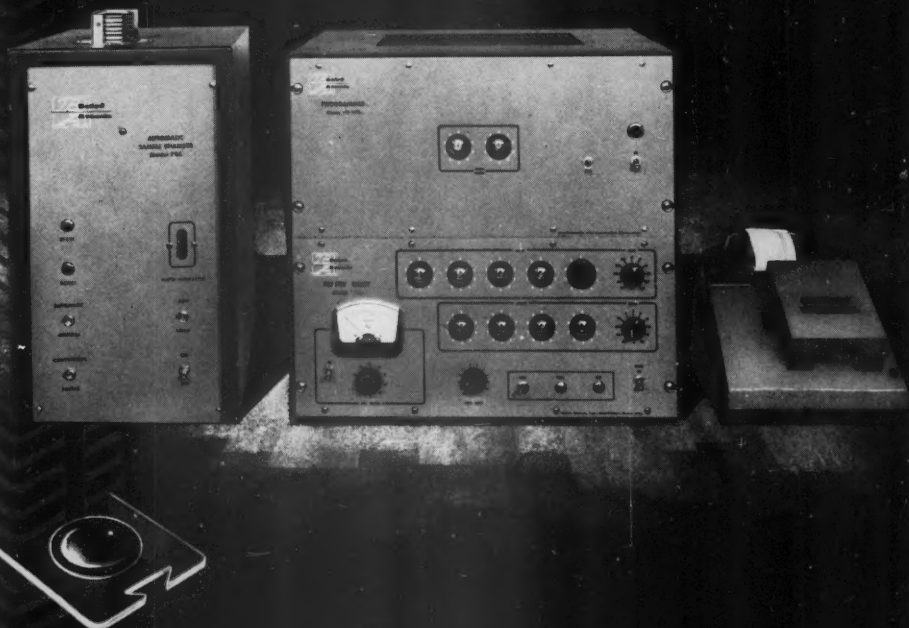
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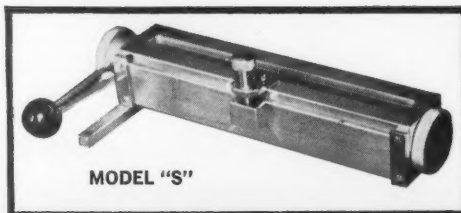
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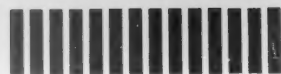
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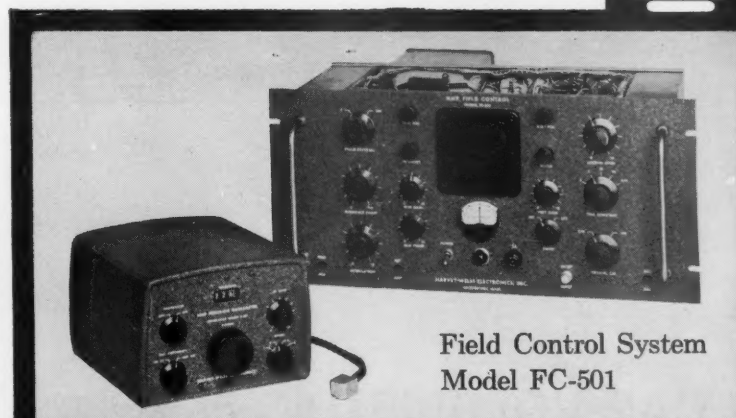
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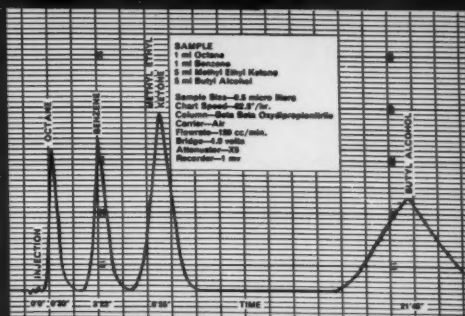
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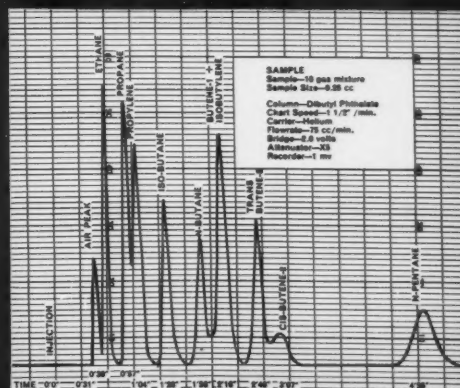


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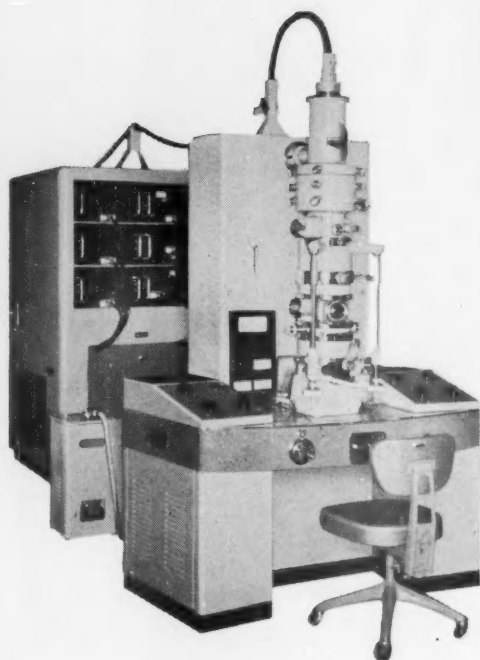
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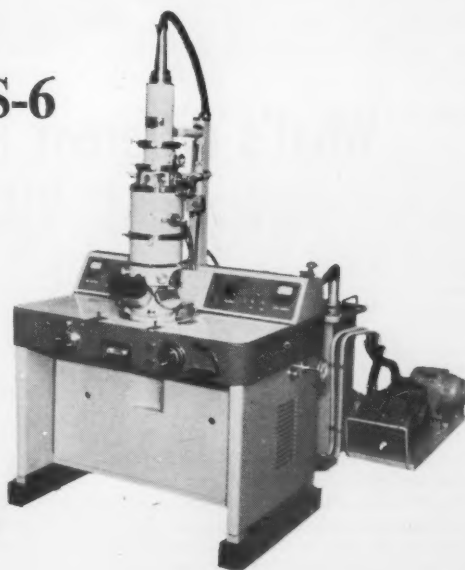
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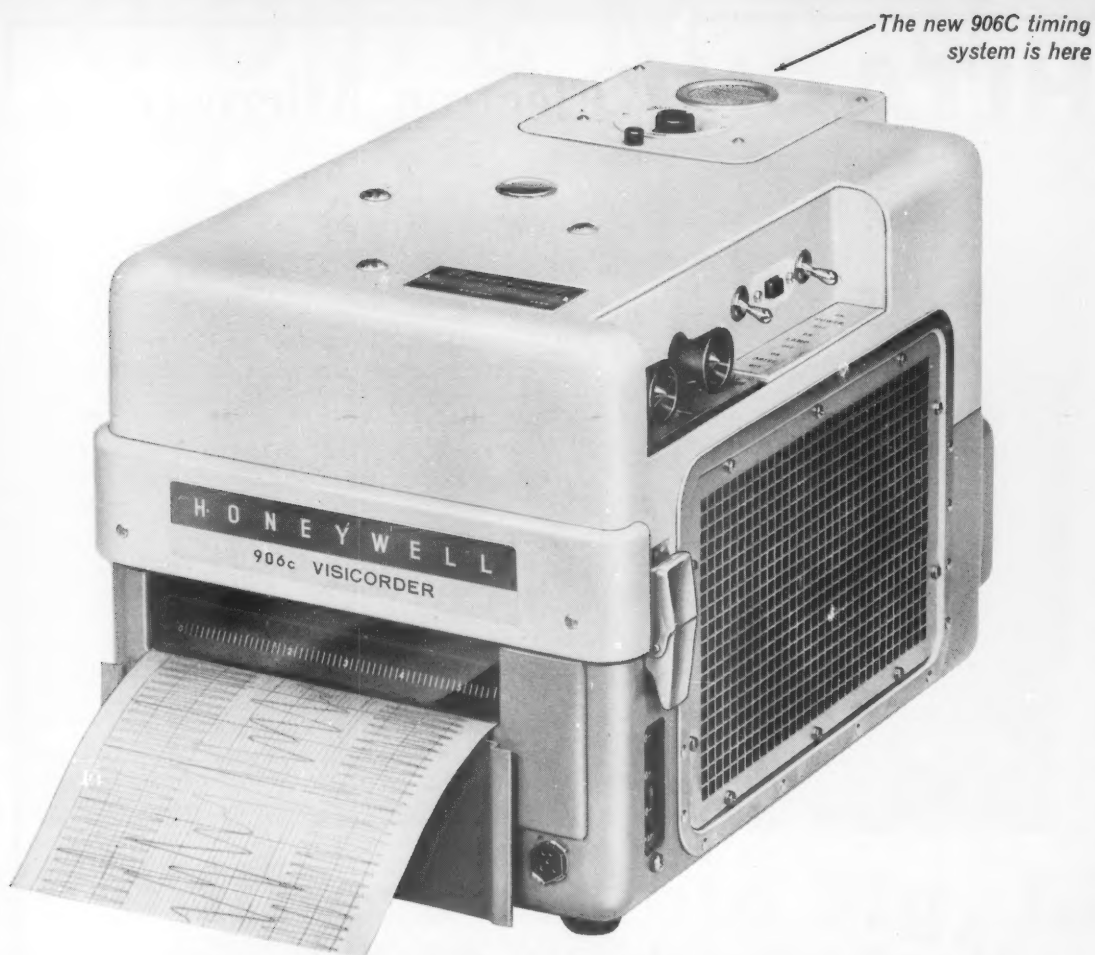
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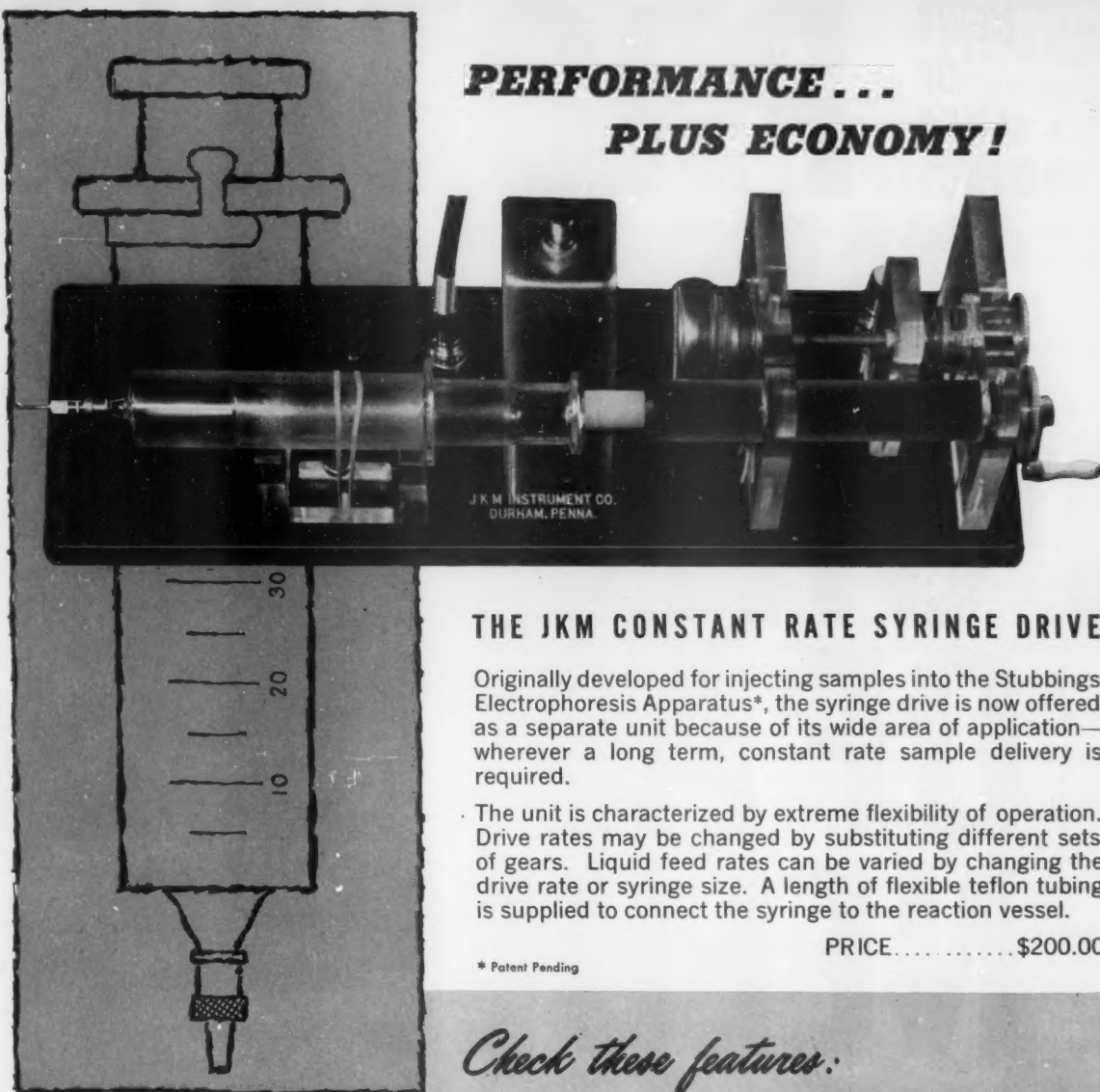
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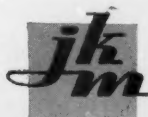
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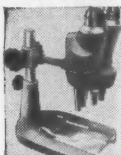
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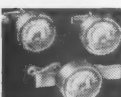
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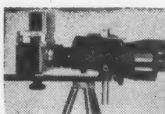


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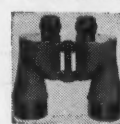


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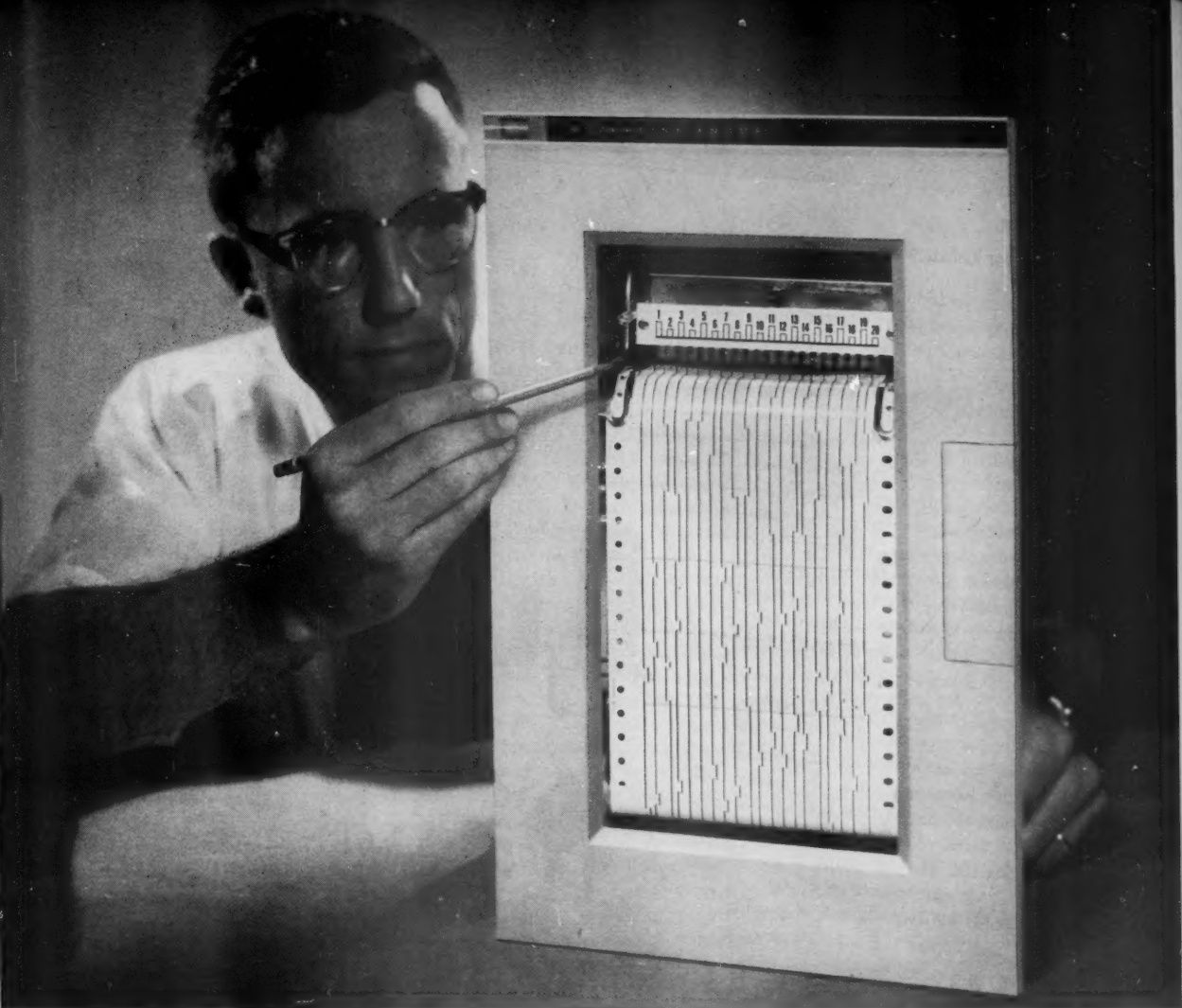
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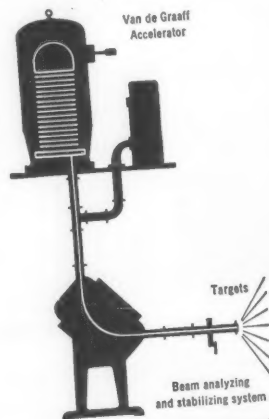
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New Categories for Old

Man, according to one famous sophistry, is a featherless biped with nails. Like a bird, man walks on two legs, but unlike a bird, he has no feathers. The possession of nails is mentioned in the definition to avoid confusion between men and plucked chickens. Much the same logic has characterized the study of some newer kinds of creatures. Recent history has seen Pentagon sophists produce similar definitions in their efforts to have missiles and other new weapons encompassed in an Army-Navy-Air Force scheme of things. But just as there are more effective ways to advance biology than by grouping together man and fowl, so there may be better ways to understand our military problems than by thinking in terms of land, sea, and air categories.

Just such an effort to provide a new set of categories is now under way in the Defense Department. Secretary McNamara and his comptroller Charles Hitch, an economist formerly with the Rand Corporation, have introduced the concept of what they call "program packages." There are seven packages, and the packages group together different military weapons and tasks in terms of similar purposes. Thus, one group is the Central War Offensive Forces program package. It includes both land-based and sea-based missile forces as well as certain aircraft forces, all of which taken together constitute our atomic retaliatory unit. Another group is the General Purposes Forces, which includes expeditionary units for fighting limited wars.

Research and development, which is understood to include all testing and evaluation of prototypes prior to operational use of a new weapon, enters the scheme in two ways. Work associated with a particular element, like the Polaris missile, is classified with that element in the appropriate package. Research efforts not so readily classified, like present military space projects, are grouped in a special program package devoted to "other" research and development.

The package-program approach cuts across not only present service classifications but also present accounting titles—personnel, maintenance, procurement, and so on. Thus, to help evaluate a possible new weapon, the new approach would provide an estimate of research and development costs, including the price of laboratory and test facilities; an estimate of the outlays for the initial equipment and training necessary to bring the new weapon into operational use; and an estimate of the recurring costs necessary to maintain the weapon once it is in use.

Improvements in planning, as might be suspected, did not start from scratch with the Kennedy administration. The idea of package programs builds on procedures that have been developing in the Defense Department during the past few years, particularly in the research and development section. Concerning earlier programing, Harold Brown, the scientific director of this section, told a congressional committee that timetables for development had proved right most of the time, but that efforts at estimating costs had been less successful. The present hope is to expand and improve on earlier efforts. What is wanted is a scheme that will explicitly array, in terms of military effectiveness and costs, the real choices among present weapons and possible future weapons.—J.T.

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CURRENT PROBLEMS IN RESEARCH

Solar Research from Rockets

The greatly broadened spectrum above the atmosphere opens a new realm for astrophysics.

R. Tousey

Study of the sun goes far back into history, but solar astrophysics is a relatively new and rapidly expanding field. The spectroscope is the key instrument. Although invented three centuries ago by Newton, its first important application to solar research was made in 1802 by Wollaston, who noted the presence of dark lines in the solar spectrum. Twelve years later Fraunhofer studied these lines in detail and showed that they are invariable in position. In 1861 Kirchhoff explained the Fraunhofer lines as produced by a cool reversing layer near the sun's limb, with temperature lower than that in the underlying bright photosphere. Only in recent years has this useful concept been shown to be an oversimplification, a better model being one where both Fraunhofer lines and continuum are formed together in a region whose temperature falls gradually to a minimum at the limb.

Photography, developed by Niepce and Daguerre in 1839, soon made possible the recording of the solar spectrum and especially of the ultraviolet. This was first accomplished by Becquerel in 1842, and was carried to great perfection by Rowland, in 1882, with the aid of his concave diffraction gratings. Then came the invention of the spectroheliograph in 1891, by Hale and by Deslandres independently, which has led to the daily recording of the chang-

ing conditions on the sun by monochromatic photography of the disc.

The corona has been studied intensively, over the last century, during the brief periods of total eclipse. Lyot's invention of the coronagraph in 1930, however, has made the inner corona visible at any time when the sky is really clear. With coronagraphs at stations scattered widely over the earth, the million-degree coronal line emissions are now monitored on a 24-hour basis.

Perhaps the most important question concerning the sun is the process by which its energy, released deep inside by the conversion of hydrogen into helium, is transmitted out through its atmosphere and radiated to the earth. An understanding of the details of this process is needed for the explanation of many solar phenomena. For example, one of the most mystifying is the 11-year periodicity in the sun's radiation output, which affects our lives in many ways. Although the total energy radiated changes so little as to defy detection, there is a many-fold increase in x-ray emission at solar maximum, as has been discovered through rocket experiments. During flares, which become far more common at maximum, emission of hard x-rays takes place, causing ionization deep within our atmosphere and radio blackout. Though the periodicity must originate in the unseeable interior, a

complete understanding of the outer regions whose radiations can be studied will surely go far toward providing the explanation.

The general nature of the sun's atmosphere is now understood from intensive study of its spectrum in the visible and near ultraviolet. There is no agreement as yet on the exact atmospheric model, and many types have been proposed. A suggested schematic model is shown in Fig. 1. The temperature falls, from the center outward, from a high value inside the sun to a minimum near 4700°K at the limb. This region is the photosphere, where the white-light continuum originates; the blue, near 4500 angstroms, is the most intense and comes from farthest inside, where the temperature is nearly 6600°K; the red and the ultraviolet come from regions closer to the limb, which are cooler. Superimposed on the continuum are the Fraunhofer absorption lines, explained by Kirchhoff's cool reversing layer.

It is now known that the temperature above the limb rises to a value of nearly one million degrees in the corona. Before the eras of rocketry and radio astronomy, this region could be studied in detail only during a solar eclipse. At the moment when an eclipse becomes total, the spectrum of the chromosphere, just outside the limb, flashes into view. In this flash spectrum the Fraunhofer lines appear as emission lines, because the photosphere and its brilliant continuum are cut out by the moon. However, lines of ionized helium, which are not present as Fraunhofer lines, are observed in the flash spectrum. Their existence requires temperatures in excess of 20,000°K. This was the first evidence that the temperature in the chromosphere rises with altitude. Farther out, the long unidentified green line at 5303 Å in the corona was shown by Edlén in 1940 to be produced by Fe XIV. The presence of

The author is head of the rocket spectroscopy branch, Atmosphere and Astrophysics Division, U.S. Naval Research Laboratory, Washington, D.C.

this highly ionized atom was indisputable evidence that the temperature must rise to about 10^6 K in the corona, since lesser energies are not sufficient to strip 13 electrons from an atom of iron.

Thus arose a problem which is still unsolved: How can the corona sustain a temperature near 10^6 K, unless energy is received from a region that is still hotter? The deep interior of the sun is indeed sufficiently hot, but the cool outer layer enveloping it acts as a screen to prevent radiation from transferring the energy.

It was clear that the inaccessible extreme ultraviolet would provide answers to many questions about the chromosphere and corona, because the resonance lines of atomic species that exist at these high temperatures lie at very short wavelengths. Observation of the sun in the extreme ultraviolet has been prevented, however, by the earth's atmosphere. From the ground, ultraviolet solar emissions can be detected

only to about 2900 Å. This abrupt termination of the spectrum was shown in 1913 by Fabry and Buisson to be caused by ozone in the earth's atmosphere. Despite attempt after attempt, this limit could not be exceeded, even through the use of stratosphere balloons, since the ozone layer is too high. All that was required to break through this impasse was a means of carrying equipment to still greater altitudes.

Rocket Spectroscopy

Through rockets, first made practical by the Germans during World War II, this dream of astronomers has been realized. It is now possible to study the solar radiations across the entire electromagnetic spectrum. The expense is high, but the rewards are great. The solar spectrum, in former times known hardly at all outside the frequency range 10^{14} to 10^{15} cycles per second, has

now been observed all the way to 10^{19} in x-rays. A similar breakthrough has been made toward the red, where the spectrum is now observed to 10^8 cycles per second by means of radio techniques, also resulting from developments of World War II. Thus, the width of the window has been increased from 1 power of ten to 11 powers of ten.

The first "rocket ultraviolet" solar spectrum was obtained by the U.S. Naval Research Laboratory (1) in 1946. For historical interest, and to point up the progress made in 15 years, it is reproduced in Fig. 2. This established indisputably the height of the ozone layer and the fact that little absorption by ozone remains at 55 kilometers. There was much excitement over this spectrum, and especially over the great absorption doublet of ionized magnesium (2802.7, 2795.5 Å), corresponding to the well-known near-ultraviolet H and K lines of ionized calcium. Improved spectra, from which detailed

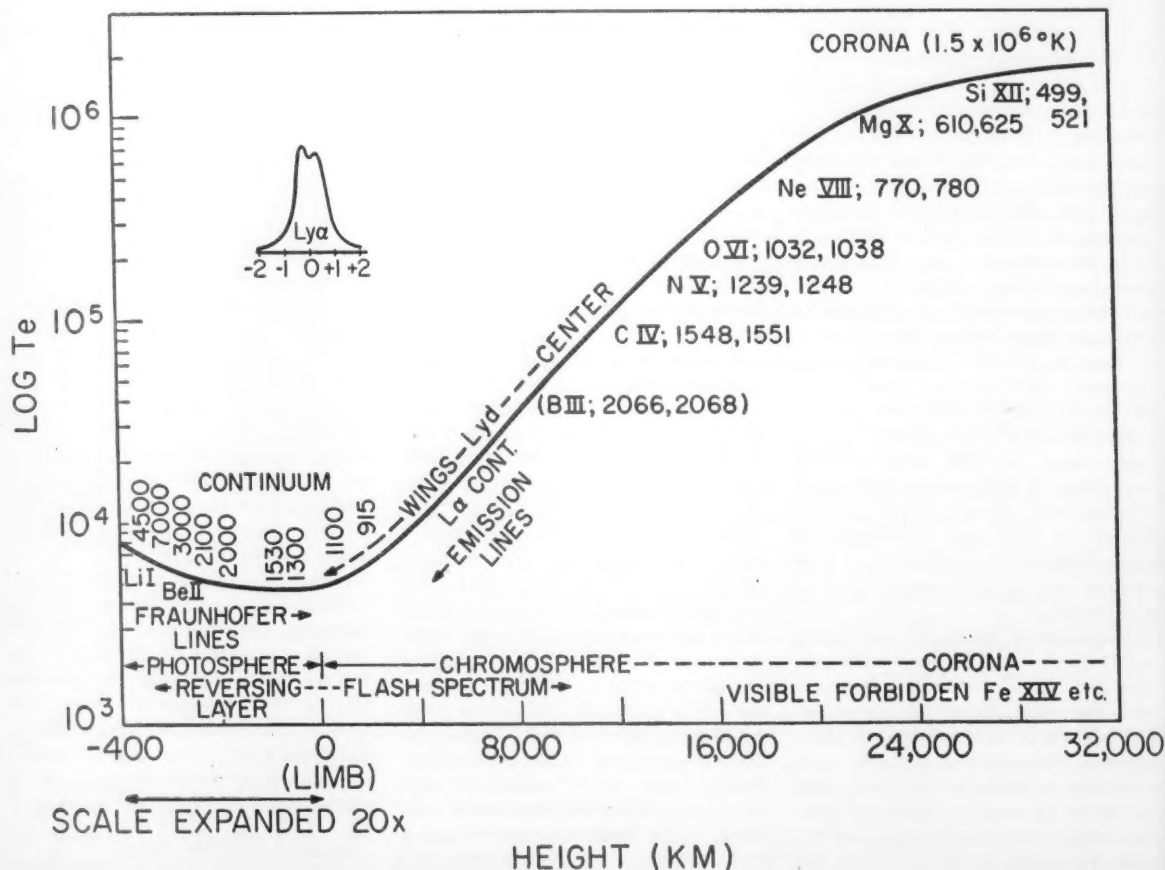


Fig. 1. A schematic model of the electron temperature in the solar atmosphere, showing the approximate positions from which the various radiations originate.

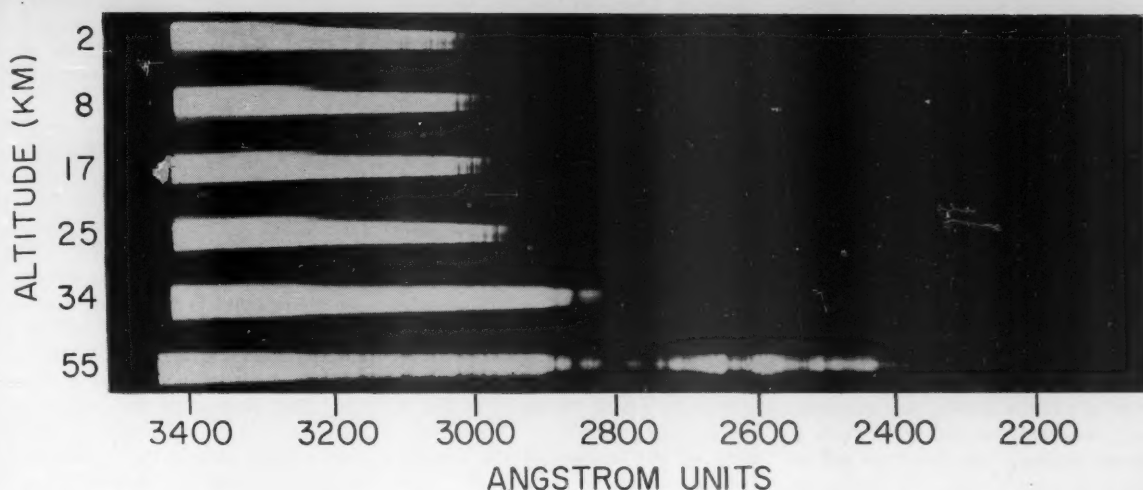


Fig. 2. The first spectrum of the sun obtained from a rocket, as photographed from a V-2 rocket by the U.S. Naval Research Laboratory (1), 10 October 1946. When the spectrograph was above the ozone layer the spectrum extended far into the ultraviolet.

studies of these emissions could be made, were eagerly awaited.

From the beginning it was apparent that rocket-borne laboratories would present many special problems not encountered in ground-based spectroscopic laboratories. The greatest difficulty is the shortness of the time available for observing. The Aerobee-High rocket, now in common use for astrophysical research, provides but 5 minutes of time above 100 kilometers, and only 2 to 3 minutes above 200 kilometers, the altitude above which there is very little absorption. Satellites now offer a possible means of surmounting this time limitation, and we may expect many advances to be made during the next 5 years, from orbiting solar observatories.

A second difficulty encountered with rockets is their unpredictable roll, yaw, and pitch. The spectrograph must be directed accurately at the sun if useful records are to be made in the short time of flight. The solution of this problem lay in the development of a solar pointing control with which a spectrograph could be aimed continuously at the sun during flight. The University of Colorado (2) succeeded in making the first practical biaxial pointing control. This device will point 40 pounds of equipment at the sun with an accuracy within 1 minute of arc and has made it possible to obtain excellent solar spectra.

At White Sands, recovery of photographic records has turned out not to be difficult. Almost always the film

cassette has been located undamaged, even after the most severe impact. More recently, however, parachute recovery of equipment has become feasible, and this offers the possibility of saving the entire instrumentation for recalibration and re-use.

The sun itself, however, continues to be a challenge to spectroscopists. Even if it were available in the laboratory, with none of the problems associated with rockets or satellites, the sun would still be extremely difficult to study, for the reason that its spectrum becomes fainter and fainter with shorter and shorter wavelengths but is extremely intense in the visible. Since most detectors of extreme ultraviolet radiation also respond well to the visible and near ultraviolet, and since only one-millionth of the sun's total energy falls in the spectral region below 1000 Å, the problem of suppressing instrumental stray light is critical. It is not difficult, in principle, to reduce the stray light by as large a factor as is necessary, but this must be accomplished without reducing the intensity of the short wavelengths themselves, which are already faint.

Many advances have been made in stray-light suppression. An excellent method is the detection of the radiation by a photomultiplier with a metal cathode. Metals have extremely low photoelectric yields for wavelengths greater than about 1300 Å, but at shorter wavelengths the yield becomes high; thus, they are relatively blind to the intense long-wavelength portion of

the solar spectrum which produces most of the stray light. Using such a photomultiplier, combined with a grazing incidence spectrograph in which the stray light intensity is extremely high, Hinteregger (3) has succeeded in reaching 65 Å with a resolution of the order of 5 Å.

For obtaining spectra of the greatest resolution, photographic film must be used, and this is highly sensitive to the stray light. In the most recent experiments by the U.S. Naval Research Laboratory (4) the stray light has been suppressed by combining two spectrographs in series. The first spectrograph consists of a concave grating which receives the sunlight, and which is arranged to disperse the spectrum up and down the slit. A second concave grating located behind the slit disperses the light at right angles to the slit and forms a spectrum in the usual fashion. Spectra obtained with this instrument are reproduced in Fig. 3. The combination of the two dispersions at right angles makes the spectrum look strangely distorted. However, double dispersion proved to be a successful method of freeing the spectrum from contamination by stray light, at least to wavelengths as short as 800 Å.

For recording the very faintest emissions it was necessary to make use of the most sensitive photographic emulsions, and of reflecting coatings and diffraction gratings of the highest efficiency. Contributing to the success of the spectrograph were the special Schumann-type, gelatine-free photo-

graphic film of Kodak-Pathé in France, produced by a centrifuging process described by Audran (5); the high-reflectance coating, magnesium fluoride over fresh aluminum, described by Hass and Tousey (6); and the blazed tripartite replica diffraction gratings ruled by Richardson at Bausch and Lomb.

The spectrum reproduced in Fig. 3 is a composite of several exposures selected to present as wide a range as possible in a single reproduction. The spectrum at the bottom was the best exposure, covering the range 950 to 1400 Å. The spectrum at the top consists of three parts; the region from 1550 to 1170 Å is from one exposure, that from 1170 to 805 Å is from a second exposure, and that from 805 to 500 Å is from a third. The portion at upper left was produced by the second-order image from the external grating and the first-order image from the main grating, while the portion near 600 Å at the bottom of the left-hand area was from the first-order image of the first grating. There is a trace of fog at the short-wavelength end, produced by light from a small leak which opened during flight, but except for this, there is no contamination of the spectrum by stray light. The region from 1500 to 2300 Å is shown in Fig. 4 (photographed with a single-dispersion spectrograph); it is pieced together from the best spectra obtained on several earlier flights.

Changing Character of the Spectrum

The spectra reproduced in Figs. 3 and 4 show the dramatic change that takes place in the character of the solar spectrum as one looks deeper and deeper into the ultraviolet. At wavelengths longer than 2085 Å the spectrum is a continuum crowded with dark Fraunhofer lines, not greatly different from the visible spectrum. Below 1530 Å the character is completely changed. Here the continuum is smooth; no Fraunhofer lines are present, but in their place there are many intense emission lines.

With the aid of the model of Fig. 1 it is possible to interpret, qualitatively, many of the features of the spectra. The photospheric continuum with Fraunhofer lines becomes less intense, and originates closer to the limb, at the shorter wavelengths; at 2100 Å the brightness temperature of the continuum is 5500°K, and the Fraunhofer lines dip down to about 5000°K. Below 2085 Å the spectrum suddenly becomes weaker and the Fraunhofer lines almost vanish, as may be seen from Fig. 4. The cause is continuous absorption of some kind, which makes it impossible to see between the Fraunhofer lines into the deeper layers. The emission level is at 5000°K. Below 2050 Å the Fraunhofer lines become a bit more conspicuous again but remain far

weaker than above 2100 Å. The Mg I line at 2026.5 Å is intense, as is the double broad feature at 1935 Å, produced by autoionization transitions of Al I.

It is tempting to ascribe the onset of continuous absorption at 2085 Å to the ionization continuum of aluminum, whose ionization limits lie at 2076.1 and 2071.3 Å. The great depth of the aluminum autoionization lines, which reach a temperature level of 4700°K, and the presence in the spectrum above 2100 Å of a number of the Al I absorption lines in the series leading up to these limits, support this explanation. This portion of the continuum, therefore, can be interpreted as arising from a region close to that of minimum temperature, with the aluminum autoionization lines arising from the minimum-temperature region.

The spectral region from 1850 to 1550 Å, shown in Fig. 4, is most interesting because it arises from the region of minimum temperature and has contributions from the photosphere below and the chromosphere above. It is the transition region between the normal Fraunhofer spectrum and the extreme ultraviolet emission-line spectrum. Here all three types of spectrum are present together—the continuum, Fraunhofer lines, and emission lines. At the resolution presently obtainable it is not easy to determine which features are emis-

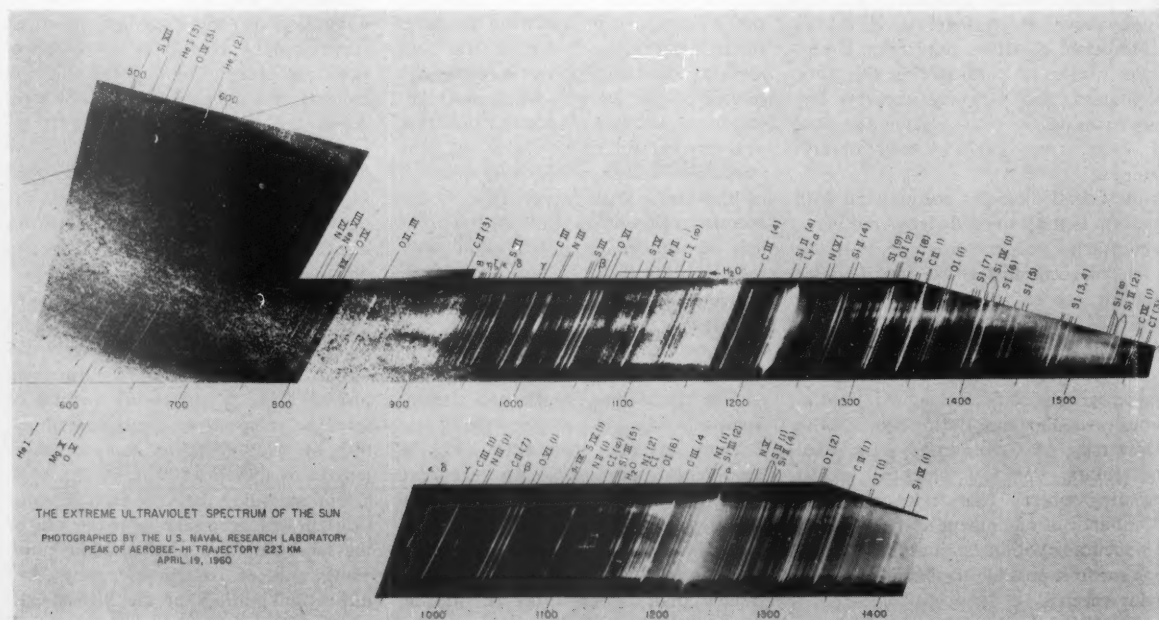


Fig. 3. The extreme ultraviolet spectrum of the sun, photographed with a double-dispersion spectrograph from an Aerobee-High rocket by the U.S. Naval Research Laboratory on 19 April 1960 (4). The upper spectrum is pieced together from three exposures, with joints at 805 and 1170 Å.

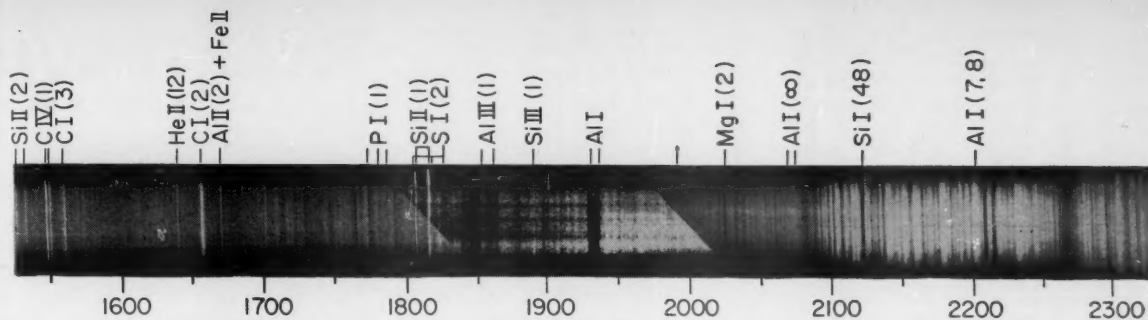


Fig. 4. The solar spectrum from 1500 to 2300 Å, photographed with a single-dispersion spectrograph by the U.S. Naval Research Laboratory. The three sections were obtained with different instruments.

sion and which are absorption, in many instances. The Fraunhofer lines can be traced toward short wavelengths to 1770 Å. The longest emission line appears at 1993 Å, but the first strong emission lines are those of Si II, at 1808.0 and 1816.9 Å.

Much of the faint structure between 1700 and 1600 Å appears to be produced by emission lines of Fe II, and from Fe II, of course, arise many strong absorption lines above 2000 Å. If the Fe II emission comes principally from a region just above the temperature minimum, at the very bottom of the chromosphere, it would be expected to appear as emission lines above the 1600-Å continuum, which arises from the lowest temperature region, and as Fraunhofer lines against the higher-temperature continuum for wavelengths greater than 2100 Å. The situation is similar for neutral sulfur, whose multiplet containing the rare ultimate near 1800 Å is seen faintly in absorption. The higher multiplets of the series appear at wavelengths below 1500 Å in emission. Thus, neutral sulfur lines also appear to be radiated from the bottom of the chromosphere, just slightly above the region of minimum temperature. In order to complete a study of the distribution of atoms in this region it will be necessary to obtain spectra at higher resolution and also to determine in the laboratory the absorption cross sections for the various atomic lines involved.

The continuum below 1530 Å has no Fraunhofer lines (see Fig. 3). There are a few regions where absorption is evident—for example, near 1120 Å. These absorptions are not solar but are produced by water vapor carried with the spectrograph and rocket.

The absence of any Fraunhofer lines at wavelengths shorter than 1530 Å means that there can be no region

in the line of sight at a temperature lower than that of the region from which the continuum arises. Since the brightness-temperature level varies between 4700° and 4750°K from 1530 to 1280 Å, the radiation must arise from the region extending from the temperature minimum a short way outward into the chromosphere.

The ending of the Fraunhofer region at 1530 Å may be the effect of the capture continuum leading to Si I, whose ionization limits are 1526.26, 1522.86, and 1521.07 Å. Silicon is an abundant element, and many lines of Si II in emission, and of Si I in absorption, are intense; therefore the capture continuum would be expected to be important.

The Lyman- α line of hydrogen, 1215.67 Å, is the most intense feature of the extreme ultraviolet spectrum. Below 1280 Å the continuum rises rapidly as the Lyman- α line is approached, then falls on the short-wavelength side. Here the emission is produced by hydrogen in the broad wings of the Lyman- α line. The continuum is surprisingly intense below 1150 Å, however, and in the original spectrum it can be traced all the way through the Lyman series of hydrogen. Its brightness temperature never falls below 5100°K.

The origin of the continuum below 1200 Å is not entirely understood. A considerable portion must be produced by the wings of the higher members of the Lyman series of hydrogen. Still another contribution appears to come from the capture continuum leading to C I, whose ionization limits lie near 1101 Å, and a similar contribution may be attributed to S I beyond its ionization limits near 1200 Å. This radiation must come mainly from the chromosphere, perhaps within 2000 kilometers of the limb.

Emission Lines

The most exciting features of the extreme ultraviolet spectra obtained with rockets are the emission lines. The various lines arise from different layers in the chromosphere and corona, and thus they may provide a great deal of information about the distribution of material and the physical processes occurring in this little understood region, where local thermodynamic equilibrium does not exist. Perhaps the best example is the lithium-like isoelectronic sequence of resonance lines, which produces line pairs extending throughout the entire spectrum, as may be seen in Fig. 3. These lines are entered on the temperature model of Fig. 1 in accordance with calculations made on the basis of the method of Woolley and Allen (7). Each succeeding element in the isoelectronic sequence requires greater energy to strip the electrons down to one in the L-shell. Therefore each must be produced farther out in the region leading to the corona, where the temperature is sufficiently high to furnish the appropriate energy.

The first members of the lithium sequence are, of course, the resonance pair of Li I, the well-known laboratory lines in the red. Because lithium is easy to ionize, these lines are not seen as Fraunhofer lines in the light of the photosphere but can be seen in sunspots, where the reduced temperature increases the concentration of neutral lithium. Next in the sequence is Be II. These lines, at 3130.4 and 3131.1 Å, are observed as faint Fraunhofer lines against the photospheric continuum. They originate in the reversing layer. Twice-ionized boron has its resonance lines at 2066.4 and 2067.9 Å, and according to calculation should arise from a region well out in the chromosphere. However, since boron

is probably at least four times less abundant than silicon, whose lines are present in this spectral range, it is not surprising that its lines do not show above the nearby moderately intense photospheric continuum. The resonance lines of C IV, however, show strongly in the spectrum at 1548.2 and 1550.8 Å; according to calculation, these should arise from a region of the chromosphere where the temperature is close to 80,000°K. Next in the sequence is N V, which can be seen at 1238.8 and 1242.8 Å. These lines are followed by the O VI lines, at 1031.9 and 1037.6 Å, which are very intense because oxygen is an abundant element in the sun. They arise from near the top of the chromosphere, where the temperature has reached 200,000°K. Next in the sequence would be F VII, but this line is not seen because fluorine is a rare element. The resonance lines of Ne VIII, however, are present in the spectrum, at 770.4 and 780.3 Å.

These are the first lines of neon to be discovered in the spectrum of the sun and the first direct proof that neon is present in the sun. Their discovery was not unexpected, since neon has been identified in stars and its cosmic abundance is equal to that of carbon. The lines of neon arise from a region very high in the chromosphere or low corona, where the temperature is of the order of 500,000°K. As yet, the lines of Na IX have not been found, but the cosmic abundance of sodium is 40 times less than that of neon. Magnesium, however, is quite abundant, and the resonance lines of Mg X are clearly present, at 609.7 and 624.9 Å. These lines may be considered coronal, since a temperature of almost 1 million degrees is required for their production. Next in the sequence would be Al XI, but aluminum, like sodium, is less abundant. Finally, there are the resonance lines of Si XII, at 499.3 and 521.1 Å. Still higher temperatures are

required for their excitation, and they must originate at a temperature level well over 1 million degrees in the corona.

In addition to these lines, many others can be seen in Fig. 3. Most are from low states of ionization of the abundant light elements, such as carbon, nitrogen, and silicon. They arise in the low chromosphere. Almost all the emission lines have been identified, but there are perhaps 25 whose origin is not known.

Hydrogen and Helium

The most abundant element in the sun is hydrogen. A knowledge of its distribution in the chromosphere is essential to an understanding of the physical processes which sustain the high temperature in the chromosphere and corona. The resonance lines of hydrogen lie in the extreme ultraviolet,

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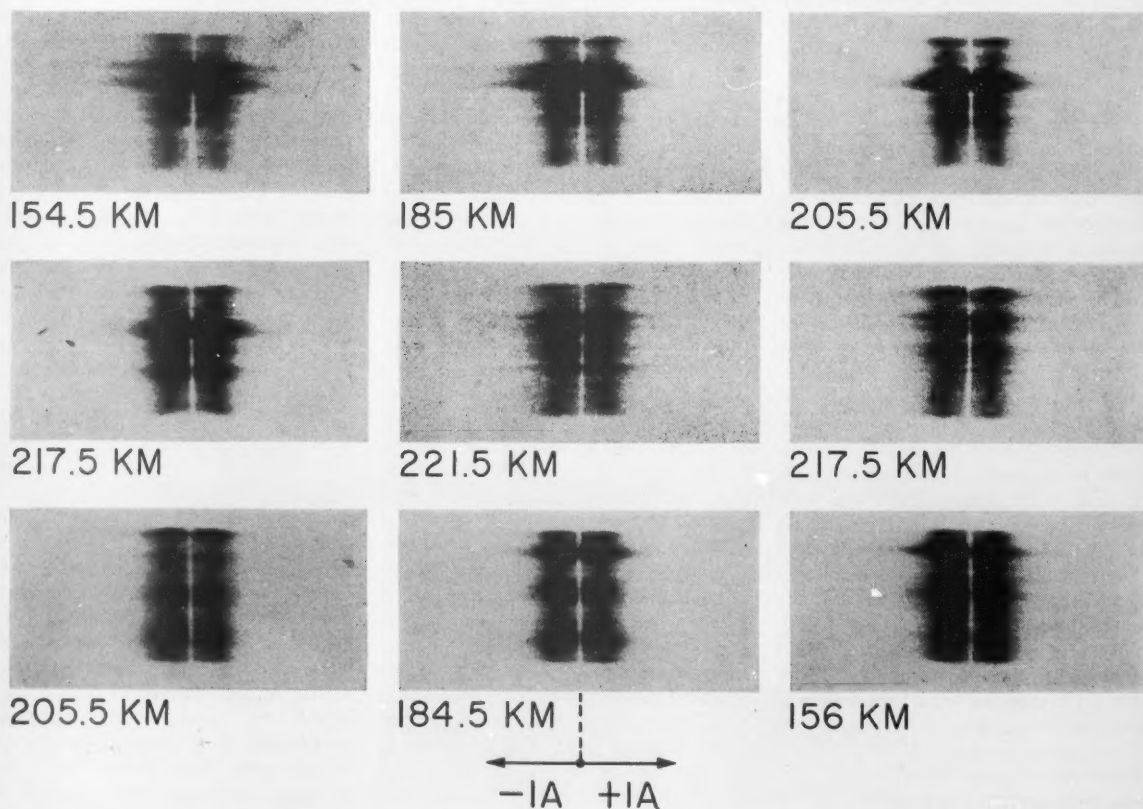


Fig. 5. Images of the Lyman- α line of hydrogen, obtained at high dispersion by the U.S. Naval Research Laboratory (8) on 19 April 1960. The narrow center absorption core is produced by hydrogen between the rocket and the sun. The bright streaks are the spectra of solar plages.

and a great deal is now known about them from the spectra obtained from rockets.

Nearly the entire Lyman series of hydrogen can be seen in Fig. 3, commencing with Lyman- α whose intensity is far higher than that of any other emission line in the extreme ultraviolet, and continuing with ten higher members of the Lyman series. Beyond the last resolved line the unresolved high

members of the series build up with the appearance of a continuum to the series limit at 912 Å; this is followed by the Lyman continuum itself, which can be traced to about 800 Å.

The profile of the Lyman- α line has been studied by the U.S. Naval Research Laboratory (8) with a high-resolution spectrograph. Nine high-dispersion images of the line, obtained on 19 April 1960, are shown in Fig. 5.

The first immediately obvious feature is the extremely narrow absorption core at the center of the line. Its width is approximately 0.04 Å. This narrow absorption line is produced by hydrogen in the region between the spectrograph and the sun. The presence of hydrogen in the upper atmosphere and exosphere has been detected with rockets, from the intense Lyman- α emission from the sky when it is

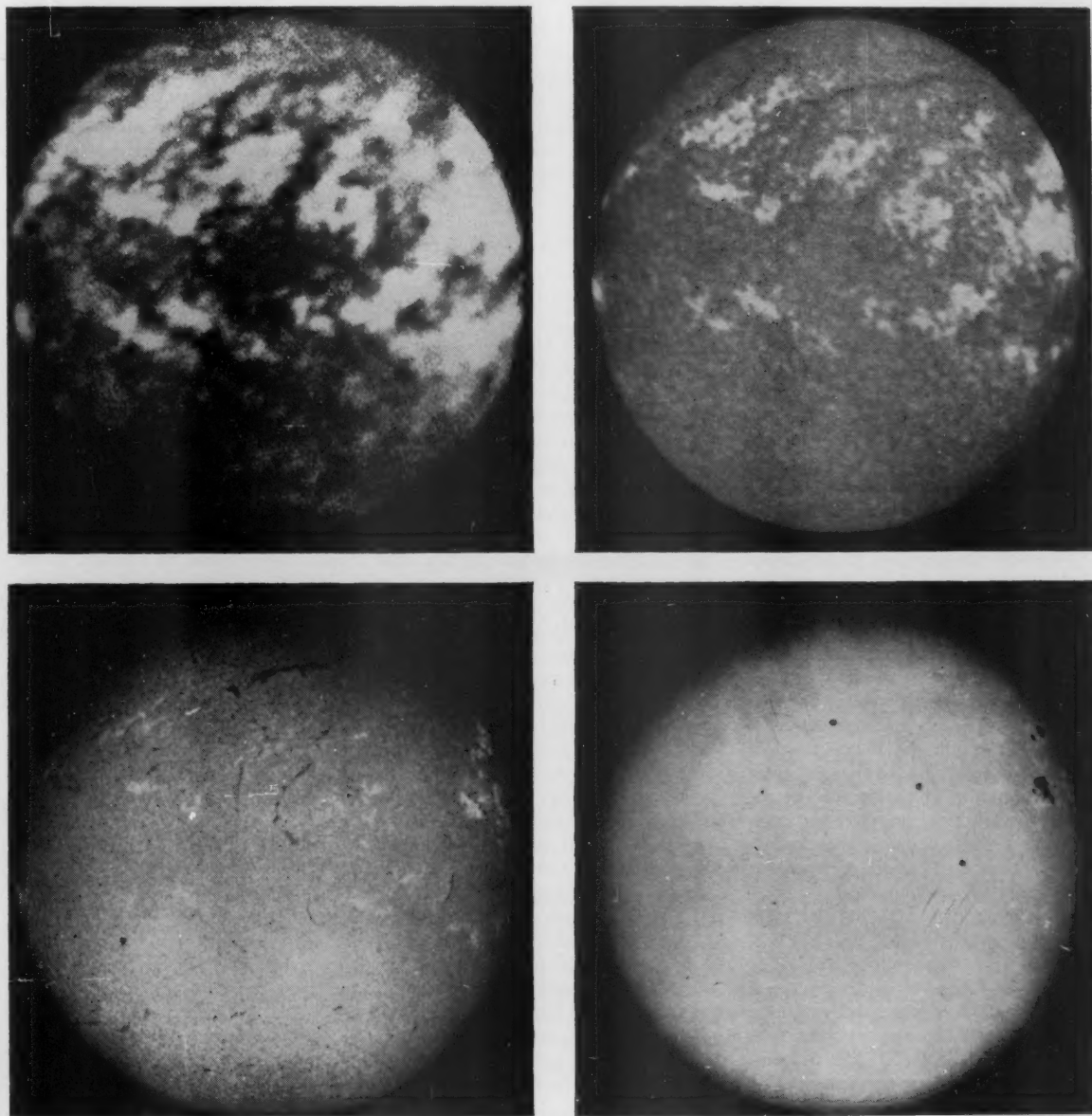


Fig. 6. Images of the sun on 13 March 1959. (Top left) Photograph taken in the light of the Lyman- α line of hydrogen from an Aerobee-High rocket; (upper right) $\text{CaK}_{2,8,2}$ spectroheliogram; (bottom left) photograph taken in the light of the hydrogen- α line with a 0.7-Å monochromatic filter; (bottom right) photograph taken in white light. [U.S. Naval Research Laboratory, McMath-Hulbert Observatory, U.S. Naval Research Laboratory, and Naval Observatory, respectively]

illuminated by sunlight. This absorption line gives a quantitative measure of the amount of hydrogen present. Photometry of the absorption core has shown that the total quantity of hydrogen required to produce the line is 3×10^{12} atoms per square-centimeter column between the spectrograph, at 100-kilometer altitude, and the sun; from the width of the line it has been determined that the temperature of the hydrogen lies between 1000° and 2000°K.

The second important aspect of the Lyman- α line is its great width. The streaks crossing the line are the spectra of different regions of the sun, of plages, and of areas of less activity. The top and bottom edges correspond to the solar limb. In the strongest plages the spectrum can be followed to more than 1 Å from the center, and, of course, it must merge smoothly into the far wings, which may be seen in Fig. 3. The center of the emission line, apart from the narrow absorption core, is broadly self-reversed, with the most intense emission occurring about $\frac{1}{4}$ Å on either side.

The width and shape of the central part of the Lyman- α line have been shown by Morton and Widing (9), in accordance with the theory of Jefferies and Thomas (10), to require emission in a region of the sun where the temperature is of the order of 80,000°K. The wings, however, are formed lower in the atmosphere, and the extreme wings, perhaps 50 Å from the center of the line, come from close to the limb. The Lyman continuum, whose radiation temperature is approximately 6700°K, arises from low in the chromosphere, where the electron temperature is of the order of 10,000°K. Continued study of the Lyman- α profile and observation of the profiles of the higher members of the Lyman series will eventually give us detailed knowledge of the distribution of hydrogen throughout the chromosphere.

In another type of study the sun's disc was photographed by the U.S. Naval Research Laboratory (11) in the light of the Lyman- α line of hydrogen by flying a monochromatic camera. This produced an image of the type generally obtained by spectroheliographs. Figure 6 shows four images of the sun obtained on 13 March 1959. The photographs were taken, respectively, in (i) the light of the Lyman- α line; (ii) the

light of the calcium K line; (iii) the light of the red line of hydrogen (this image was obtained with a Lyot filter); and (iv) ordinary white light. The Lyman- α emission pattern over the sun shows more contrast and is coarser than any of the others. According to the result obtained from the profile of the center of the line, the Lyman- α emission shown in Fig. 6 must arise from the level in the sun near 7000 kilometers, where the temperature is nearly 100,000°K. The red line of hydrogen, however, comes from a lower region of the chromosphere, where the temperature is approximately 10,000°K—perhaps from 4000 kilometers above the limb—and the calcium-K emission is thought to originate even lower down. In future experiments it is planned to photograph the sun in the light of other emission lines, thus securing maps of the atmosphere for many different levels. It would be especially interesting to obtain images with the various lines in the lithium sequence.

The solar lines of helium in the extreme ultraviolet are of great importance, since a detailed study of their intensities and profiles would lead to a better determination of the abundance of helium in the sun's atmosphere and of its distribution in the chromosphere. This is of interest in connection with the origin of the sun. It is believed that the sun's atmosphere has the same composition as the original cloud of gas from which the sun was formed by condensation. Although the heat produced by the sun is produced by the conversion of hydrogen into helium deep inside the sun, it appears that little or none of the helium so formed leaks to the surface to change the composition of the sun's atmosphere.

Two helium lines are present in the spectrum shown in Fig. 3, the 584.3-Å resonance line of neutral helium and the second line of the series, at 537 Å. The resonance line of He II at 303.8 Å has been photographed by Rense (12) and observed photoelectrically by Hinteregger (3); a trace of the third-order image of this line, at 911.4 Å, appears near the head of the Lyman continuum in Fig. 3. The Balmer series of He II is clearly present in the spectra of Figs. 3 and 4. Its first line, at 1640.5 Å, is conspicuous. The higher lines in the series should be present in Fig. 3. However, every second line is blended

with a line of the Lyman series, and several of the lines lying between members of the Lyman series happen to be blended with other emission lines. Traces of several of the high lines of the series have been identified. It appears that it will eventually be possible to apply the techniques of high-resolution spectroscopy and monochromatic photography to the He I line at 584 Å and the He II line at 304 Å and so to obtain detailed knowledge of the distribution and abundance of helium in the atmosphere of the sun.

Plans for solar research from rockets and satellites include many new and interesting experiments. With control of rocket orientation during flight it will soon be possible to study in greater detail many aspects of the solar spectrum in the extreme ultraviolet—to study changes in the spectrum very close to the limb; to make line identifications from 500 Å even into the x-ray region; and, by monochromatic photography, to study the pattern of emission over the disc of the different lines in the lithium-like sequence. Satellites, on the other hand, offer the possibility of studying the outer corona, which is now visible only at total eclipse, on an hour-to-hour basis. This region contains the strange streamers that may, indeed, stretch to the earth itself, sending to us the charged particles that become trapped to form the Van Allen belts. Observation of changes in these weird forms from day to day, or even from hour to hour, may well provide the key to many of the effects taking place in the earth's atmosphere, and may possibly throw new light on the problem of changes in the earth's weather.

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X-ray Fluorescence Analysis in Biology

Both standard and special x-ray methods can help in the difficult study of low-concentration elements.

Theodore Hall

Only a few chemical elements are abundant in living materials. The nucleic acids consist mainly of carbon, nitrogen, oxygen, hydrogen, and phosphorus; sulfur is needed for proteins; and calcium for bone. All the other chemical elements found in living matter have been called "minor constituents." Although the "minor" elements are omitted from the crude diagrams of many important molecules and often appear in tissues only in very low concentrations, we know that they are tremendously important.

Today we have a variety of instruments for measuring the concentrations of the minor elements. These measurements must be made if we are to understand the many roles of the minor elements in life. Many desirable assays are still technically beyond us. This article describes the place of one measuring tool, x-ray fluorescence analysis, in the exploration of the low-concentration elements in biology.

Before discussing the contribution that this method can make, let us briefly review the foundations of the technique.

Primer

The analysis of chemical elements by x-ray fluorescence is analogous to emission spectroscopy. In both cases, elements are excited to emit their characteristic radiations, and the instrument distinguishes between the wavelengths associated with the different elements. In emission spectroscopy (as the term

is usually used) the excitation affects the outer electrons of the various atoms and the radiation is in the visible or near-visible region. In x-ray analysis, inner electrons are ionized and the wavelengths are much shorter, approximately 0.2 to 10 angstroms.

The term *fluorescence* refers to the characteristic radiation emitted by a material when it is exposed to radiation of shorter wavelengths. Most x-ray analysis of elements is "fluorescence" analysis, in the strictest sense of the word, because the characteristic x-rays are usually excited by exposing the specimen to other x-rays. Alternatively, one can use an electron beam for excitation, a method which has become popular recently and is considered briefly at the end of this article. In this case the characteristic x-rays are not "fluorescent" in the strict sense of the word, and the method is more properly placed under the general heading of x-ray emission spectroscopy.

Any x-ray fluorescence analysis system includes an x-ray source to excite the specimens and an analytical system to discriminate between the radiations from the different elements in a specimen and to measure the intensity of each element's contribution. The x-ray detector is generally either a gas-filled tube (a Geiger or proportional counter) or a scintillation crystal coupled to a photomultiplier. With any of these detectors, each incident x-ray quantum may be converted to a discrete electrical pulse. The pulses are counted or recorded by scalers or counting rate meters.

In commercial instruments (see Fig. 1) a diffracting crystal is mounted between specimen and detector (as shown in

Fig. 2). At any moment, ideally, x-rays from only one element enter the detector. The diffracting crystal generally discriminates quite cleanly against all the other elements in the specimen (1, 2).

X-ray analysis has some major advantages.

1) X-ray spectra correspond to the simple pattern of energy levels of inner atomic orbits; this results in relatively uniform sensitivity over a wide range of atomic numbers.

2) Because the energies of the inner electron orbits are affected only negligibly by chemical binding, element analysis is independent of chemical state even in unprocessed specimens.

3) Preparation of the specimen is usually simple. Often the specimen can be placed directly in the x-ray beam without preparation.

4) X-ray analysis is essentially non-destructive in that constituents of the specimen are not displaced (molecular bonds may be ruptured).

X-ray analysis also has some major disadvantages.

1) Absorption and self-excitation effects in the specimen ("matrix effects") necessitate elaborate calibration curves for quantitative work, except in the case of thin specimens.

2) In the region of atomic numbers 12 to 22, helium or vacuum specimen chambers are desirable to avoid excessive attenuation of the "soft" characteristic x-rays. For atomic numbers below 12, attenuation makes x-ray analysis impractical for most applications.

In mineralogy and metallurgy, where x-ray fluorescence has its widest use, the sensitivity limits for standard instruments are considered to be one or a few micrograms of an element of interest per specimen, in minimum concentrations of around 10^{-4} (3). However, as petroleum analysts have known for some time (4), sensitivity is higher with organic specimens because of the much longer mean free paths for background scattering and for absorption in material of low atomic number. Natelson considers the measurement of 0.1 microgram of iodine to be feasible in organic specimens (5). As shown in a subsequent section, various modifications of the standard arrangement of Fig. 2 can extend the performance much further in certain biological studies. But first I shall review the practicable biological applications of standard x-ray analysis units.

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Application of Standard Instruments in Biology

For reasons of speed, simplicity, and reliability, x-ray analysis is a preferred method wherever its sensitivity is high enough for handling specimens after mere drying. Examples of such applications are clinical assays for iron, calcium, potassium, chlorine, sulfur, and phosphorus in blood (5, 6), and for bromine in blood and urine in cases of bromide poisoning (7).

Without specimen preparation more elaborate than mere drying, the minor elements generally cannot be measured in tissues (zinc and iron may be exceptions). Hence, "as-is" analyses are limited mainly to the cases above and to special situations, such as measurements of iodine in the thyroid gland, of pathological accumulations, or of the metallic constituent of an extracted metalloenzyme.

With preconcentration techniques the group of feasible analyses is significantly enlarged. Examples are the assay of strontium in bone and in serum after ashing (8) and the assay of bromine in a centrifuged liver fraction from a bromine-intoxicated individual (7). The

attractiveness of x-ray analysis after element concentration depends partly on the merits of competing techniques, represented in Table 1. (The reader must recognize that there are sweeping approximations in such a compressed tabulation.)

General reviews of x-ray analytical applications (9) list few items in the field of biology. This is partly because biological analysts are more familiar with other techniques. Most of the methods of Table 1 require considerable preparation of specimens; with similar effort devoted to chemical concentration, x-ray analysis could be applied relatively conveniently to many biological specimens. However, for the purpose of scanning a wide variety of tissues for a wide variety of minor elements [as Tipton (10) has done, for example], one must use techniques with which lower element concentrations and smaller amounts can be measured, such as emission spectroscopy and neutron activation.

In sum, a commercial x-ray fluorescence analysis unit is very desirable for routine, mass-production assays of certain minor elements, including some of the most important clinical assays. The

instrument cannot be the major resource of a laboratory devoted to general research on the minor elements in biological tissues, but it can be quite useful in such a laboratory as one of a group of analytical tools.

Histological Localization

It may be far from easy to determine the role of a minor element in a biological issue. For example (this is discussed at greater length in a subsequent section), no one knows whether zinc plays any role in the prostate gland even though the extraordinary concentration of the element there has been investigated by many scientists since its discovery 40 years ago (11). Element assay in a gross piece of tissue can be provocative but is not enlightening. To gain understanding, we must localize elements in some way—localize them, for example, to a biochemical fraction such as an enzyme, or to a separated cellular component such as the mitochondrion, or histologically to a cell type such as the islet cells of the pancreas.

Today's instruments are least satisfactory for histological localization. It is very desirable to analyze individual tissue sections and to inspect either the identical or the adjacent sections microscopically, in order to discover any correlations between element concentrations, cell types, and pathological conditions. Since an element is often studied in just those tissues where its concentration is strikingly high, the technical challenge may not involve assays at very low concentrations, but it does involve very small amounts. A conventional tissue section, perhaps 0.1 square centimeter in area and about 10 microns thick, weighs only about 0.1 milligram. Even at, let us say, the relatively high minor-element concentration of 10^{-5} , there will be only about 10^{-6} gram of an element of interest per section. None of the techniques listed in Table 1 provides convenient measurements of such small amounts of elements in such small specimens, especially if one prefers not to destroy the sections (12).

For the histological localization of minor elements, the most popular methods are radioautography and histochemical staining. In the most favorable cases each of these methods can provide localization with a resolution approaching that of the microscope. Other methods are still needed because

Table 1. Capabilities of some methods for assay of chemical elements.

Minimum amount (μg)	Minimum concentration* ppm	concentration* $\mu\text{g}/\text{ml}$	Range of elements†	Independent of chemical state?	Nondestructive?	Reference
<i>Emission spectroscopy</i>						
10^{-4} –0.01		0.002–0.2	N, 41 Z, 3–92	Yes	No	(26)
0.01–0.3	3–100		N, 12			(27)
<i>Flame photometry</i>						
		0.002–0.1	Li, Na, K, Ca, Mn, Cu, Rb, Sr	Yes	No	(26)
1–15			Ca, K, Na			(28)
<i>Atomic absorption spectroscopy</i>						
		0.03–2	N, 13 Z, 11–79	Yes	No	(29)
<i>Colorimetry</i>						
		0.001–0.2	N, 31 Z, 4–82	Yes	No	(26)
0.4–5			B, Fe, Mg, P, S			(28)
<i>Neutron activation</i>						
10^{-6} –0.1			N, 61 Z, 11–92	Yes	No	(30)
<i>Mass spectroscopy</i>						
$\sim 10^{-6}$	$\sim 10^{-6}$		N, 68	Yes	No	(31)
<i>Electron spin resonance</i>						
$\sim 10^{-5}$ – 10^{-4}			Transition elements	No	Conceivably	(32)
<i>X-ray fluorescence (commercial)</i>						
0.1–1	1–10		Z, 12–92	Yes	Yes	(33)

* Concentration in the specimen fed to the device. The concentration in the original specimen may be much lower if preconcentration is used. † N = number of elements; Z = atomic numbers. Elements outside the indicated range may be measurable, but with sensitivities poorer than shown.

these two are not quantitative and are often found to be inapplicable. Furthermore, it is quite difficult to establish the specificity and uniformity of a histochemical stain in a chemically complex tissue.

I now discuss a modified x-ray fluorescence system by which measurements may conveniently be made of the average concentration of an interesting element in a histologist's tissue section (although the sensitivity is not high enough for making measurements on micro-areas within the section).

Nondispersive X-ray Analysis and Histology

When a standard x-ray instrument is set to assay for a particular element, the diffracting crystal (Fig. 2) rejects not only x-ray quanta from other elements but also, unfortunately, most of the quanta from the element of interest. Only the fraction that strikes the crystal face within a certain small range of angles is passed on to the detector. Sensitivity is lost through this waste of good quanta.

An alternative arrangement, with no diffracting crystal (Fig. 3), is called "nondispersive" because x-rays of different wavelengths are not spatially dispersed. X-rays of all wavelengths reach the detector, which then has the job of distinguishing between them. Nondispersive instruments may have only one detector; the reason for the second detector in Fig. 3 is explained later.

At full power dispersive x-ray instruments yield "absolute sensitivities" of 10^7 to 10^8 counts per second per gram of element of interest. The absolute sensitivity of a given instrument for a given element can be increased by a factor of the order of 100 (a conservative figure) by the act of omitting the diffractor and rearranging the components nondispersively. Nevertheless, nondispersive instruments are rare, for the good reason that only diffractors can resolve the complex spectra involved in most applications.

For several reasons the x-ray spectra excited in histological specimens are relatively simple. The low average atomic number results in relatively weak background radiation from the bulk of the specimen. In studying certain interesting elements like zinc and iron, one encounters few interfering elements of comparable concentration. Finally, in

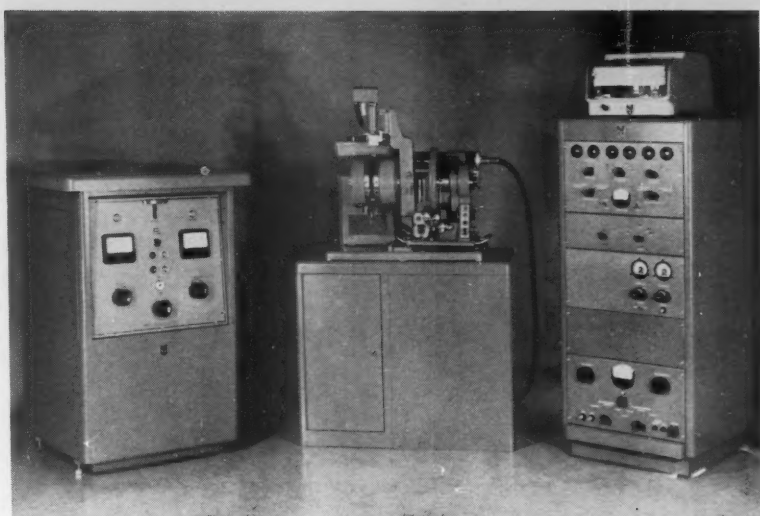


Fig. 1. A standard x-ray fluorescence analyzer. [Philips Electronic Instruments]

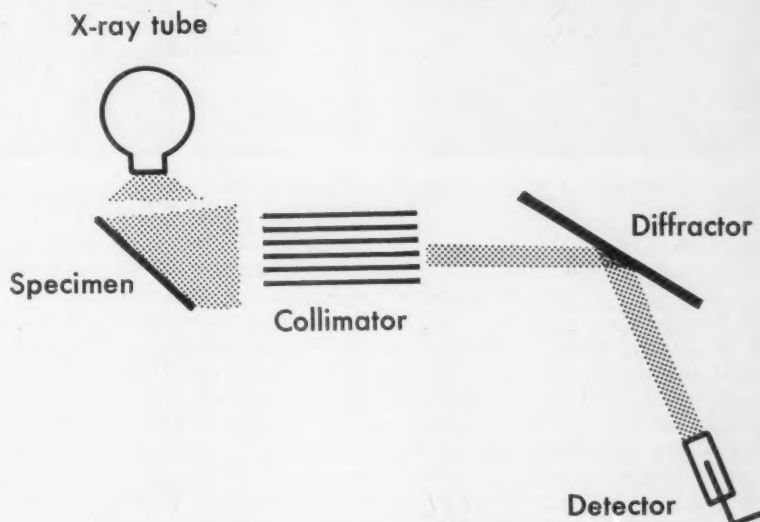


Fig. 2. A standard arrangement for x-ray fluorescence analysis.

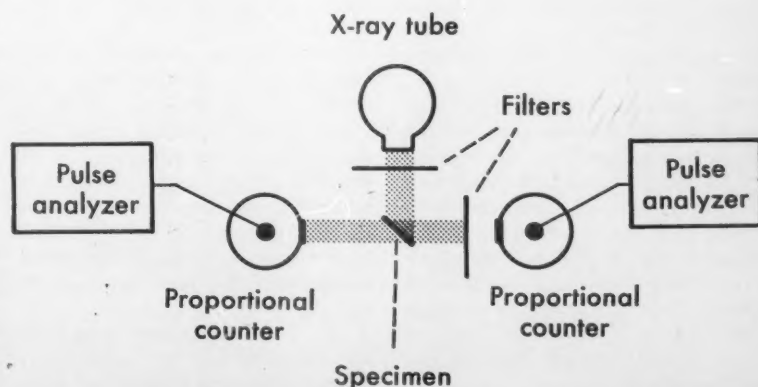


Fig. 3. Arrangement for nondispersive x-ray fluorescence analysis.

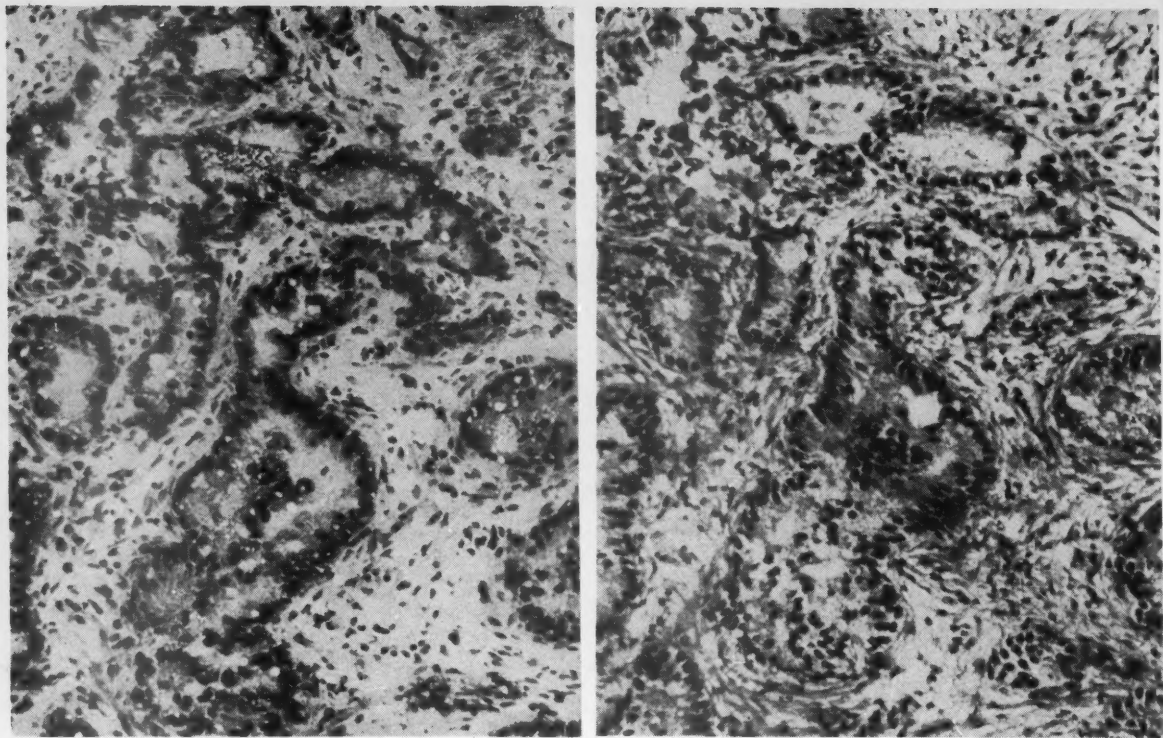


Fig. 4. Sections from a malignant prostate. (Left) Stained after x-ray analysis; (right) stained immediately after sectioning. ($\times 100$)

thin sections, "matrix effects" (that is, attenuation and self-excitation in the specimen) are negligible. Consequently nondispersive x-ray fluorescence analysis is quite practical for a number of histological studies.

For nondispersive work the detector should be a proportional counter coupled to a pulse-height selector. For each element, the proportional counter produces electrical pulses of an average height proportional to the characteristic x-ray quantum energy, so that the selector can be set to respond to one element while discriminating against all others. The rejection is not perfect but is adequate for many biological studies.

The proportional counter is least successful in discriminating between x-rays from elements that are adjacent in the periodic table. Here filters may be especially helpful, since, through a large part of the periodic table, a filter of atomic number $Z-2$ will absorb radiation from element Z much more strongly than it will absorb radiation from $Z-1$. With two counters and one filter (Fig. 3), adjacent elements may be resolved.

It is also necessary to simplify the spectrum of the x-rays incident on the

specimens, since the instrumental background is due largely to the electromagnetic scattering of these x-rays into the detector. Such scattering occurs with virtually no change in wavelength. In the biological study described below, the radiation leaving the x-ray tube was filtered to remove almost all intensity at wavelengths near the characteristic lines of the element of interest. Later I discuss briefly an inherently superior method for producing clean exciting spectra, the "secondary radiator" method, application of which has been delayed because of certain technical problems.

Extremely thin and clean specimen supports are essential for histological analyses. Many specimens yield only a few hundred registered quanta from the element of interest during a 10-minute run. Even the widely used $\frac{1}{4}$ -mil Mylar film would produce an intolerable background. In this laboratory, specimens are mounted on "home-made" single-layer nylon films approximately 0.01 mil thick.

The low-concentration limit, both for dispersive and for nondispersive systems, depends on backgrounds arising from scattered quanta (unless element interference intrudes, in the nondis-

persive case). With pulse-height selection, cleansed exciting spectra and thin specimen supports, background is remarkably reduced. Under such conditions, in a typical nondispersive analysis the counting rates from an element of interest and from background may be equal at a concentration of approximately 20 parts per million in a dried biological specimen, which is equivalent to 4 or 5 parts per million before drying in most soft tissues. This compares quite favorably with the signal-to-background ratio for dispersive systems under their usual operating conditions.

The mediocre resolving power of a nondispersive system makes it poorly suited for scanning for a large number of elements in a given specimen and prohibits certain assays entirely. For example, nondispersive x-ray fluorescence studies of cobalt in unprocessed tissues will probably never be feasible because cobalt occurs in much lower concentration than iron and copper, which are close to it in atomic number. As I hope to illustrate below, a nondispersive system can make a special contribution to an intensive study of a single element, with instrument filtration and excitation appropriately tailored to the element of interest.

Operational Aspects of One Nondispersive Analytical System

Analysts will be interested in certain features of histological x-ray assay, as practiced in this laboratory.

To calibrate, one sets a pulse-height selector to count the pulses produced by an element of interest. A second selector simultaneously monitors the main x-ray line in the exciting radiation. This line is scattered into the detector with an intensity proportional to the mass of the specimen. For thin specimens the ratio

$$\frac{\text{counts from fluorescing element}}{\text{counts from scattered exciting line}}$$

is independent of specimen size. Furthermore, because carbon, nitrogen, oxygen, and all soft biological tissues scatter with virtually the same intensity per unit mass at the wavelengths in question, this ratio is a direct and simple index of concentration. All specimens lacking the element of interest will produce the same (background) ratio, and

the increase over this base-line ratio observed in any specimen is linearly proportional to the concentration of the element of interest. Therefore, calibration requires only two samples—a pure organic spot (sucrose, in our studies) and a similar spot with a known enrichment of the element of interest.

Specimens are assayed dry, in a vacuum. Drying reduces the mass of most soft biological materials by a factor of 4 or more, and the corresponding reduction in scattered background is very important for low-concentration work. There is a more compelling reason for assaying in a vacuum: at atmospheric pressure the air mass in the sensitive volume around a thin section would weigh more than the specimen itself, and the mass count would lose meaning.

Contamination and displacement hazards prohibit the use of conventional paraffin-sectioning procedures. Sections are cut frozen in a cryostat, then are transferred directly to the nylon support film, pumped dry, and assayed with no further processing. Element

concentration can be correlated with the microscopic appearance of the specimen either by staining and inspecting a neighboring section or by staining and inspecting the original section after x-ray assay. Specimens transferred from the nylon support and stained after assay generally appear to be in poorer condition than their serial counterparts, but they can be used for purposes of correlation. (Any damage they show is presumably not from the x-ray beam but from handling and from the delays before drying and staining.) To be able to inspect an assayed section, rather than a neighboring section, microscopically is especially valuable when an assay shows a surprising result and contamination is feared.

In our procedures, contamination hazards from reagents and containers are slight because these are used very little. Special sources of contamination must be identified and removed. A glass tool should be used to transfer sections from microtome knife to nylon film; the more common camel's-hair brush, if touched to the film, can de-

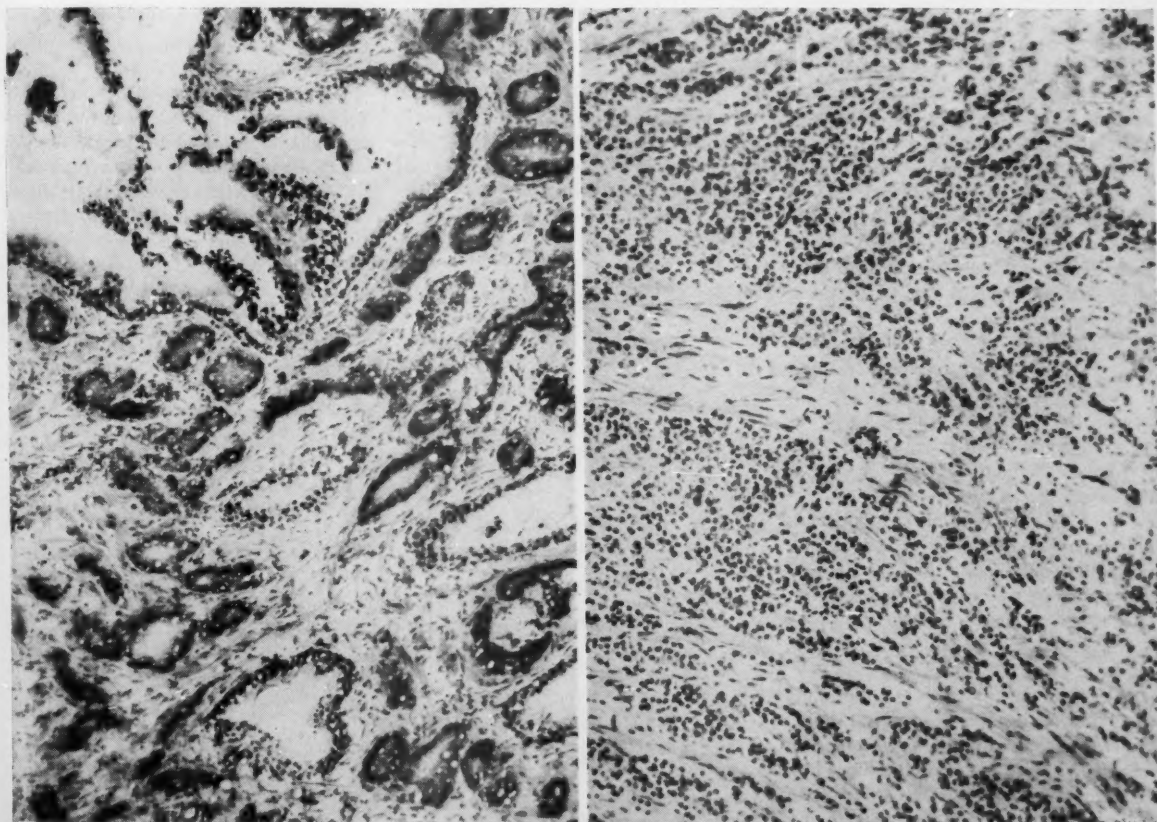


Fig. 5 (left). Section from a malignant prostate. Fig. 6 (right). Section from a malignant prostate. (about $\times 78$)

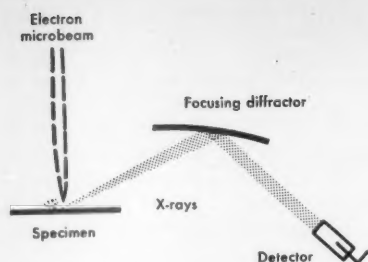


Fig. 7. Arrangement for electron-beam microanalysis.

posit more of an element of interest than is contained in a tissue section. The cryostat operator's sheepskin gloves must be sheathed in plastic to eliminate microscopic shedding. Good technique of a more conventional kind is needed to make adequately clean nylon films. But in general the simplicity of specimen processing makes contamination less of a problem than one might expect with specimens containing 10^{-6} to 10^{-10} gram of an element of interest.

Zinc in Prostatic Tissue

Results obtainable through nondispersive analysis are well illustrated by a study that is now in progress, involving prostatic tissue and the element zinc.

In several mammalian species the concentration of zinc in the prostate gland is about 10 times higher than it is in most soft tissues. Some urologists have wondered if malignancy or benign enlargement of the human prostate gland could be controlled by injecting a zinc-complexing agent. In a recent study (13) initiated by the urology section at the Sloan-Kettering Institute it was shown that dramatic selective effects occur in the canine prostate after injection of the zinc-complexing compound diphenylthiocarbazone (dithizone). The effect seems to depend strongly on the concentration of zinc in the tissue. Therefore it became important to determine the zinc levels prevailing in malignant human prostatic tissue, in order to judge the prospects for clinical response to a metal binder.

It has been known for some time that the mean zinc concentration is much lower in malignant prostates than in healthy ones (14). This fact does not necessarily imply a lowered zinc level in the malignant epithelial cells themselves, especially since malignant pros-

tates may contain relatively little epithelium. Histochemical staining (15) indicates lowered zinc levels in the malignant cells themselves, but this method is not quantitative. A small drop in concentration or even changes in permeability can cause a large loss in staining intensity. The most conclusive data yet published show a correlation between element content and histological and pathological condition in small pieces of tissue (16). In collaboration with G. Randolph Schrodt of the pathology division and with the urology section at the Sloan-Kettering Institute, my co-workers and I are trying to sharpen this correlation by a series of zinc assays in individual prostate tissue sections.

Figure 4 shows malignant prostatic biopsy material from a patient who has had conventional estrogen therapy (the two halves of the figure demonstrate the nondestructive nature of the fluorescence analysis). The average zinc concentration in the assayed 10-micron section was 0.17 ± 0.02 milligram per gram of dried tissue, a relatively low value typical for prostatic tissue after estrogen treatment or castration.

Figure 5 shows malignant prostatic biopsy material from an untreated patient. The average zinc concentration in this rather well differentiated 10-micron section was 0.42 ± 0.04 milligram per gram of dried tissue, only about half the average value for the normal human prostate but consider-

ably higher than the average for most (estrogen-treated) prostatic cancers.

Figure 6 shows dedifferentiated malignant, highly epithelial biopsy material from a patient with untreated prostatic cancer. The average zinc concentration for the adjacent (histologically very similar) 10-micron section was 0.43 ± 0.04 milligram per gram of dried tissue. Since our observations and those of others have shown that zinc in prostatic tissue is concentrated in the epithelial cells, and since the section shown in Fig. 6 is much more epithelial than that shown in Fig. 5, it appears that the zinc concentration in the malignant cells is much lower in the tissue of Fig. 6 than in that of Fig. 5.

Figures 4 to 6, selected from a developing series, are shown here solely to exemplify an experimental approach. I draw no biological conclusions at this point. We believe that nondispersive x-ray analysis of tissue sections, as illustrated, will increase our knowledge of the zinc concentrations prevalent in malignant prostatic cells and tissues.

Biological Potential of Methods Related to X-ray Fluorescence

Time has yet to establish the scope of applications in biology of several modern methods of x-ray analysis for chemical elements.

In microradiographs of thin tissue

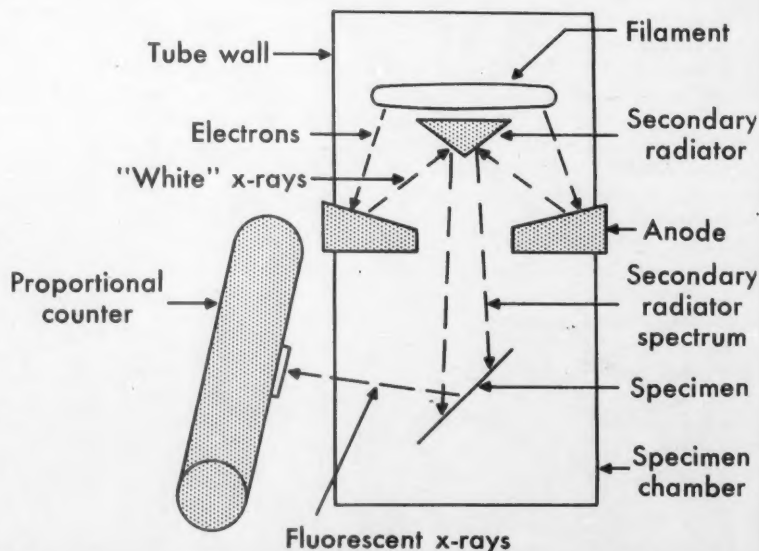


Fig. 8. Arrangement for secondary-radiator x-ray fluorescence analysis. [From Hall (2), reproduced by permission of John Wiley and Sons, Inc.]

sections, resolutions of 1 micron or better may be achieved. The distribution of an element within a section may be displayed in contrasting microradiographs, produced successively with x-ray wavelengths on the highly absorbing and the less highly absorbing sides of that element's critical absorption edge (17). Only a few elements in a few tissues are concentrated highly enough to be studied in this way (18). The technique can be very informative wherever it is applicable.

The outstanding recent development in x-ray analysis for chemical elements is the electron-probe microanalyzer introduced by Castaing and Guinier (19). Here the x-ray tube of a fluorescence system is replaced by an electron beam focused onto a specimen spot of the order of 1 micron in diameter (Fig. 7). The microarea under analysis at any moment can be viewed with a built-in microscope. By moving the specimen or scanning with the electron beam, one may map the distribution of an element over the specimen surface. Amounts of elements as low as 10^{-14} gram may be measurable (20). This instrumental approach has proved so valuable in metallurgy that several commercial versions are now available, some costing more than \$100,000. Biological applications involve special problems: specimen lability, matrix-effect complications, limitations in measurable concentration and in the microscopy of the unstained specimens, and the fact that in the small volumes most efficiently analyzed by the device there may not be even 10^{-14} gram of an element of interest. Hence the role of the electron-probe microanalyzer in biology is still to be established.

Several instruments are based on the principle of the "point" x-ray sources which can be produced with electron microbeams (20). Such a source has been used with the absorption-edge method to measure 10^{-10} to 10^{-12} gram of an element (usually calcium) in selected areas of biological specimens, 2 to 10 microns in diameter (21). Recently a similar source has been used in a fluorescence arrangement for measuring concentrations down to about 10^{-11} gram in similar

microareas (22). The range of biological applications for these instruments is not yet defined.

In nondispersive analysis, "secondary radiators" should be very useful (Fig. 8). The output from a secondary radiator consists almost entirely of the few characteristic x-ray lines of the radiator element, with very little continuous-spectrum background. Proper choice of the radiator element can give an exciting spectrum that is both very efficient for a particular element of interest and very low in background near that element's wavelength. The potential of secondary-radiator devices was recognized several years ago (23) and explored in theoretical and pilot studies (1, 24). The realization of this potential has been delayed by problems of electron trajectories in the unconventional geometry of a secondary-radiator x-ray tube. It is hoped that a unit now under development in this laboratory will extend the list of measurable elements well beyond the limits imposed by the nondispersive system described here.

Summary

Our efforts to understand the important biological roles of many "minor" elements are limited by the capabilities of the existing instruments. X-ray fluorescence analysis is not the most sensitive method for the assay of minor elements, but it is the instrumental technique of choice both for certain clinical studies and for certain research problems. The technique will be more widely used as it becomes more widely known (25).

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The Psychology of the Scientist

A definite personality pattern, encompassing a wide range of traits, characterizes the creative scientist.

Anne Roe

Science is the creation of scientists, and every scientific advance bears somehow the mark of the man who made it. The artist exposes himself in his work; the scientist seems rather to hide in his, but he is there. Surely the historian of science must understand the man if he is fully to understand the progress of science, and he must have some comprehension of the science if he is to understand the men who make it.

The general *public* image of the scientist has not been and indeed is not now a flattering one, and at best it certainly is not an endearing one. Characterizations of scientists almost always emphasize the objectivity of their work and describe their cold, detached, impassive, unconcerned observation of phenomena which have no emotional meaning for them. This could hardly be further from the truth. The scientist as a person is a nonparticipating observer in only a very limited sense. He does not *interact* with what he is observing, but he does participate as a person. It is, perhaps, this fact—that the scientist does not expect, indeed does not want, the things that he is concerned with to be equally concerned with him—that has given others this impression of coldness, remoteness, and objectivity. (The social scientist is in a remarkably difficult position since the “objects with which he is concerned” are people, and both they and he may be more than a little ambivalent about this matter of interaction. But this is a special problem which I will by-pass

here, noting only that in many ways the social scientist differs from the natural scientist in terms of personality and motivations.)

The truth of the matter is that the creative scientist, whatever his field, is very deeply involved emotionally and personally in his work, and that he himself is his own most essential tool. We must consider both the subjectivity of science and what kinds of people scientists are.

The Personal Factor

But first we must consider the processes of science. Suppose we take the scientist at the time when he has asked a question, or has set up a hypothesis which he wants to test. *He* must decide what observations to make. It is simply not possible to observe everything that goes on under a given set of conditions; he must choose what to observe, what measurements to make, how fine these measurements are to be, how to record them. These choices are never dictated entirely by the question or hypothesis (and anyway, that too bears his own particular stamp). One has only to consider how differently several of his colleagues would go about testing the same hypothesis to see that personal choice enters in here.

But this is just the beginning. Having decided what is to be observed, and having set up the techniques for observing, the scientist comes to the point of making the actual observations, and of recording these observations. All the complex apparatus of modern science is only a means of extending the range of man's sensory and perceptual capac-

ities, and all the information derived through such extensions must eventually be reduced to some form in which man, with his biological limitations, can receive it. Here, too, in spite of all precautions and in spite of complete honesty, the personal factor enters in. The records of two observers will not dovetail exactly, even when they read figures from a dial. Errors may creep in, and the direction of the error is more likely than not to be associated with the observer's interest in how the findings come out. Perhaps the clearest evidence on this point comes from research on extrasensory perception. A scientist who is deeply committed to a hypothesis is well advised to have a neutral observer if the import of an observation is immediately apparent. Often, of course, such errors are minor, but they can be important, not only to the immediate problem but to society. I have wondered to what extent the disparity in figures on radioactive fallout may reflect such factors. Very few scientists, including psychologists, who have demonstrated selective perception as a laboratory exercise, take account of the phenomenon in their own work.

Once the observations are recorded, other questions are asked: When is the evidence sufficient to be conclusive, one way or the other? How important are discrepancies? What degree of generalization is permissible? Here, again, we may expect personally slanted answers. Taxonomy offers a very clear illustration of the effect of personality: One biologist may classify a given set of specimens into a few species, and another may classify them into many species. Whether the specimens are seen as representing a few or many groups depends largely on whether one looks for similarities or for differences, on whether one looks at the forest or the trees. A “lumper” may honestly find it impossible to understand how a “splitter” arrives at such an obviously incorrect solution, and vice versa. Such differences cannot be resolved by appeal to the “facts”—there are no facts which cannot be perceived in different ways. This is not to say that the facts are necessarily distorted. The problem of the criterion exists in all science, although some scientists are more aware of it than others.

The matter of personal commitment to a hypothesis is one that deserves more consideration than it usually receives. Any man who has gone through the emotional process of developing a

The author is lecturer on education in the Graduate School of Education, Harvard University, Cambridge, Mass. This article is adapted from a lecture presented 28 December 1960 before the History of Science Society at the annual meeting of the AAAS, in New York.

new idea, of constructing a new hypothesis, is to some extent, and usually to a large extent, committed to that hypothesis in a very real sense. It is his baby. It is as much his creation as a painting is the personal creation of the painter. True, in the long run it stands or falls, is accepted or rejected, on its own merits, but its creator has a personal stake in it. The scientist has more at stake than the artist, for data which may support or invalidate his hypothesis are in the public domain in a sense in which art criticism never is. It may even be because of this that scientists customarily check their hypotheses as far as they can before they state them publicly. And, indeed, the experienced scientist continues to check, hoping that if errors are to be found, it will be he who finds them, so that he will have a chance to make revisions, or even to discard the hypothesis, should that prove necessary. He finds it less difficult to discard his hypothesis if, in his efforts at checking, he has been able to come up with another one.

The extent of personal commitment to a hypothesis is a prominent factor in the historical interplay between scientists. The degree of this commitment varies in an individual with different hypotheses, and varies between individuals. One very important factor here is the scientist's productivity. If he has many new ideas he will be less disturbed (and less defensive) if one fails to pan out. If he has very few ideas, an error is much harder to take, and there are many historical instances of errors which the author of the idea has never been able to see himself. I think many scientists are genuinely unaware of the extent, or even of the fact, of this personal involvement, and themselves accept the myth of impersonal objectivity. This is really very unfortunate. It is true that only a man who is passionately involved in his work is likely to make important contributions, but the committed man who knows he is committed and can come to terms with this fact has a good chance of getting beyond his commitment and of learning how to disassociate himself from his idea when this is necessary. There is little in the traditional education of scientists to prepare them for this necessity, and there are many who are still unaware of it. The extent of a scientist's personal involvement in a theory can now be a matter of grave public concern. Scientists who become advisers on political or other policy

have an extraordinarily heavy responsibility for achieving some detachment from their own theories. How many of them realize this?

But once one hypothesis is found acceptable, this is not the end of it. One hypothesis inevitably leads to another; answering one question makes it possible to ask other, hopefully more precise ones. And so a new hypothesis or a new theory is offered. How is this new theory arrived at? This is one expression of the creative process, and it is a completely personal process. It is personal regardless of whether one or more individuals is involved, for in every advance made by a group, the person contributing at the moment has had to assimilate the contributions of the others and order them in his own personal way.

The Creative Process

There have been many millions of words written about the creative process, few of them very illuminating. The reason is not hard to find. The process is intimate and personal and characteristically takes place not at the level of full consciousness but at subconscious or preconscious levels. It has been inaccessible to study largely because we have not yet found any means for controlling it. Many effective scientists and artists have learned a few techniques which may reduce interference with it, but no one to my knowledge has discovered any means by which he can set it in motion at will.

It is probable that the fundamentals of the creative process are the same in all fields, but in those fields in which an advance in knowledge is sought, there is an additional requirement—or rather, one requirement receives particular emphasis. This is the need for a large store of knowledge and experience. The broader the scientist's experience and the more extensive his stock of knowledge, the greater the possibility of a real breakthrough.

The creative process involves a scanning or searching through stocks of stored memories. There seems to be a rather sharp limit to the possibility of very significant advance through voluntary, logical scanning of these stores. For one thing, they vary enormously in their accessibility to conscious recall and in the specificity of their connections, so that reliance upon conscious, orderly, logical thinking is not likely to

produce many results at this stage, however essential such procedures become later in verification. This scanning is typically for patterns and complex associations rather than for isolated units. It may be, however, that a small unit acts as a sort of key to a pattern. What seems to happen, in creative efforts in science as well as in every other field, is that the individual enters a state in which logical thinking is submerged and in which thought is prelogical. Such thought is described as random largely because it typically tries seemingly illogical and distantly related materials, and it often makes major advances in just this way. It is not fully random, however, because it is goal-directed and because even in this preconscious work there is appropriate selection and rejection of available connections. This stage of the creative process is accompanied by generally confused or vague states of preoccupation of varying degrees of depth; it is well described as "stewing." It is this stage which apparently cannot be hurried or controlled.

Although termination of this stage (finding a solution, or "getting insight," as it is often called) quite frequently occurs in a moment of dispersed attention, it apparently does not help to induce a state of dispersed attention in the hope of provoking a quicker end to the process. It should be added that, while insights do frequently occur "in a flash," they need not do so, and that the process is the same whether or not the insight turns out to have validity.

To acquire the necessary store of knowledge requires long and difficult application, and as science advances, the amount of information to be assimilated becomes greater and greater, despite increasing generalization in the organizing of the data. Obviously, as more experience is stored and as the interconnections become better established and more numerous, the scanning becomes more effective. Such interconnections develop more and more readily as the process of acquiring experience takes on significance in the light of theory. This process requires not only the basic capacity to assimilate experiences but very strong motivation to persist in the effort. Strong motivation is also required if one is to continue with a search which may for a long time be unproductive. Motivation of this kind and strength derives from the needs and structure of the personality. Its sources are rarely obvious, although they can sometimes be traced. They do

not necessarily derive from "neurotic problems," although they frequently do. It is no cause for dismay when they do. The ability of the human being to find in a personal problem motivation for a search for truth is one of the major accomplishments of the species.

If past experiences have brought about a compartmentalization of the storage areas, so that some portions are partially or wholly inaccessible, obviously the scientist is limited in his search. Compartmentalization of particular areas may result from personal experiences of a sort that lead to neurotic structures generally, or it may result from specific cultural restrictions, such as political or religious indoctrination. The extent to which such indoctrination will inhibit creative effort, however, depends upon how close the inaccessible areas are in content to the problems at issue. We have fairly conclusive evidence that political indoctrination need not interfere with inquiry into mathematical and physical science. Religious indoctrination can interfere strongly at any point, as history has documented very fully for us. The conclusion is no different from the basic principle of therapy: the more areas of experience there are accessible to conscious and preconscious thought, the better are the prospects for creativity.

Once an apparent answer to the scientist's question has been found, there is still a long process of pursuing and checking to be gone through. Not every man who can produce new ideas is also good at the business of checking them, and of course the reverse is also true. It is in the utilization of such personal differences as these that a "team approach" can make sense.

The Creative Scientist

This, then, is a brief review of what little we know of the process of creation. What do we know of the characteristics of scientists who can use this process effectively? Many lines of inquiry have demonstrated that the range of characteristics that are associated with creative productivity in a human being is very wide. These characteristics fall into almost all categories into which personal traits have been divided for purposes of study—abilities, interests, drives, temperament, and so on.

To limit our discussion to scientific productivity, it is clear to start with that there are great variations in the

amount of curiosity possessed by different people. Curiosity appears to be a basic drive. I suspect it may vary consistently with sex, on either a biological or a cultural basis, but we have as yet no idea how to measure such drives. No one becomes a scientist without a better-than-average amount of curiosity, regardless of whether he was born with it, was brought up in a stimulating environment, or just did not have it severely inhibited.

Intelligence and creativity are not identical, but intelligence does play a role in scientific creativity—rather more than it may play in some other forms of creativity. In general, one may summarize by saying that the minimum intelligence required for creative production in science is considerably better than average, but that, given this, other variables contribute more to variance in performance. It must also be noted that special abilities (numerical, spatial, verbal, and so on) play somewhat different roles in different scientific fields, but that ability must in no case be below average. A cultural anthropologist, for example, has little need for great facility with numbers. An experimental physicist, on the other hand, does require facility with numbers, although he need not have great facility with words.

Personality Patterns

A number of studies have contributed to the picture of the personality patterns of productive scientists, and it is rather striking that quite different kinds of investigations have produced closely similar results. These can be briefly summarized in six different groups, as follows:

1) Truly creative scientists seek experience and action and are independent and self-sufficient with regard to perception, cognition, and behavior. These findings have been expressed in various studies in such terms as the following: they are more observant than others and value this quality; they are more independent with respect to cognition and value judgments; they have high dominance; they have high autonomy; they are Bohemian or radical; they are not subject to group standards and control; they are highly egocentric.

2) They have a preference for apparent but resolvable disorder and for an esthetic ordering of forms of experi-

ence. They have high tolerance for ambiguity, but they also like to put an end to it in their own way—and in their own time.

3) They have strong egos (whether this derives from or is responsible for their independence and their tolerance for ambiguity is a moot question). This ego strength permits them to regress to preconscious states with certainty that they will return from these states. They have less compulsive superegos than others. They are capable of disciplined management of means leading to significant experience. They have no feeling of guilt about the independence of thought and action mentioned above. They have strong control of their impulses.

4) Their interpersonal relations are generally of low intensity. They are reported to be ungregarious, not talkative (this does not apply to social scientists), and rather asocial. There is an apparent tendency to femininity in highly original men, and to masculinity in highly original women, but this may be a cultural interpretation of the generally increased sensitivity of the men and the intellectual capacity and interests of the women. They dislike interpersonal controversy in any form and are especially sensitive to interpersonal aggression.

5) They show much stronger preoccupation with things and ideas than with people. They dislike introversion and affect-associated preoccupations, except in connection with their own research.

6) They like to take the calculated risk, but it must involve nature, not people, and must not depend on simple luck.

Conclusions

How do these personality characteristics relate to the creative process in science as I have discussed it? An open attitude toward experience makes possible accumulation of experience with relatively little compartmentalization; independence of perception, cognition, and behavior permit greater than average reordering of this accumulated experience (the behavioral eccentricities so often noted are consistent with this). The strong liking for turning disorder into order carries such individuals through the searching period which their tolerance for ambiguity permits them to enter. The strong egos, as noted, permit regression to prelogical forms

of thought without serious fear of failure to get back to logical ones. Preoccupation with things and ideas rather than with people is obviously characteristic of natural scientists, and even of some social scientists. This characteristic is not directly related to creativity, I think, but rather to the content of it.

I need not add that such statements

as these are generalizations and that any individual case may be an exception. We may go farther, however, and generalize differences among men who follow different branches of science. That a man chooses to become a scientist and succeeds means that he has the temperament and personality as well as the ability and opportunity to do so. The branch of science he

chooses, even the specific problems he chooses and the way he works on them, are intimately related to what he is and to his deepest needs. The more deeply engaged he is, the more profoundly is this true. To understand what he does, one must try to know what his work means to him. The chances are that he does not know or care to know. Indeed, he does not need to know. We do.

Science and the News

The School Bill: As Usual It Is in Trouble; Notes on Disarmament, Satellites and Radio Astronomy

It was generally reported last week, for the fourth time during the congressional session, that the school bill was dead, and the outlook for supporters of the bill was indeed even dimmer than usual. The remarkable event that triggered the latest batch of dismal reports was the decision of Senators Morse and Hill, chairmen respectively of the Senate subcommittee on education and of the full Senate Committee on Labor and Public Welfare, to sponsor a separate bill for the extension of school aid to the impacted areas.

(The impacted areas program provides grants in lieu of taxes to school districts containing substantial tax-free government property. Three out of four Congressmen and all Senators have impacted areas within their constituencies. The program expired in June, and one of the few things that can be said with absolute certainty about Congress is that it is not going to go home and face the voters without renewing aid for impacted areas.)

The principal hope for the immensely controversial general school bill was to tie it to the immensely popular extension of the impacted areas program; and the fact that two of the leading Democratic supporters of school aid were sponsoring a separate impacted areas bill suggested that the Democrats were throwing in the towel.

For all this, the latest reports of the

demise of Kennedy's program, like the earlier ones, have been, at the least, premature. Welfare Secretary Ribicoff insists that the Administration is not giving up on the bill "until the last gavel falls," as he put it, and the last gavel, announcing the end of the congressional session, is not expected to fall for another month, during which time the Administration has considerable room for maneuvering.

What was, and remains, necessary for general school aid to be forced through the reluctant House was aggressive lobbying from the White House. This required a delay of a showdown on education until after the foreign aid bill had cleared Congress for the President's signature. The two Houses were expected to have passed their respective versions of the foreign aid bill this week, and a compromise version, worked out by a House-Senate conference, may be ready for a final vote next week. The way will then be clear for the President to move on education, although the White House has as yet made no public commitments on what, if anything, the President will do to break the log jam in the House of Representatives, where the whole Administration education program — school aid, National Defense Education Act extension, and aid to colleges — has been blocked in the Rules Committee.

The Morse-Hill move in the Senate last week was intended mainly to assure that, if the school bill failed this year, the aid to impacted areas would

receive only a 1-year, rather than its usual 3-year, extension, thus making it possible next year to make another attempt at forcing through general aid to schools by tying it to extension of impacted areas aid. The Senate action had the incidental effect of warning the quite large bloc of fence-sitters in the House, who would prefer not to have to vote either way on the delicate issue of general aid, that if the House failed to face the issue this year, it would probably have to face it next year, an election year.

Meanwhile, responsible Administration aides have been hinting that the President might veto even a 1-year extension of impacted areas aid if that is all that gets through Congress. This, together with the accompanying message explaining why the bill was vetoed, would be the most dramatic possible way of focusing the nation's attention on the education program, and particularly on the failure of the House even to face the issue and vote the program up or down.

But this would be a politically drastic as well as a dramatic step, for the pressure to renew impacted areas aid is great enough to assure eventual passage, if necessary over the President's veto. If a veto, and the accompanying furor, forces the House to act on the broader education program, it will be a great victory for the Administration, but if it fails to force broader House action, and impacted areas aid only is pushed through, despite the veto, the Administration's defeat will only look so much worse.

What suggests that, barring a change of mood in the House, the President might take such a risk is that after calling school aid probably the most important piece of domestic legislation, and after the brave talk of his aides about fighting "until the last gavel falls," he is going to look a little silly if he simply takes a complete defeat lying down.

Disarmament

On a broader matter, the principal American and British negotiators were scheduled to return to Geneva next week for another try at reaching a test ban agreement, but there was no real expectation that anything would come of the new try. The Russians have repeatedly restated their position, including their insistence on the "troika" principle, with East, West, and neutrals each given a veto over the administration of the treaty. The Russians insist that they are not going to give up the troika idea, because their experience in the Congo, where, they say, the neutral administrator actually favored the West, has convinced them that there is no such thing as a neutral man, and that if everyone's interest is going to be safeguarded it must be by giving everyone a veto over all administrative decisions. The Russians say this will not make the inspection system meaningless, since if a disturbance meets the criteria for an inspectable event, an inspection cannot be vetoed.

The West is unconvinced by such an argument; for who decides whether the disturbance meets the criteria? The troika. Thus the Russians could not veto the inspection of a certified suspicious event, they could only veto the administrative decision that a given disturbance is a suspicious event. Beyond the specific problem in this case, the West is fully against accepting the troika principle in any case, for its adoption would set a precedent for Russian insistence on similar arrangements for all international organizations. The Russian argument, after all, is not that some special circumstances here require the adoption of the troika, but that as a general principle all international agencies should be controlled by the troika.

Kennedy said that if Ambassador Dean finds no change in the Russian position next week, he will be brought home again, and the President will then make "the appropriate decisions." But there is small likelihood that these "appropriate decisions" will include a decision for a prompt resumption of weapons testing. As noted here two weeks ago, the general world situation makes such a decision unlikely in the immediate future. If, as is expected, Dean gets nowhere with the Russians next week, the next major episode will probably come at the United Nations General Assembly meeting, beginning in late September, where the United

States and Britain have asked for a full debate on the test-ban question.

At that General Assembly meeting the United States and Britain will also present a Western plan for general disarmament, intended to counteract the unfavorable impression left in recent sessions by the American reluctance to discuss large-scale disarmament. The American plan, now being circulated among our allies, apparently will not only contain the traditional stress on adequate controls but, more strongly than has been done in the past, will build a case for the need for effective means of settling international disputes peacefully as a prerequisite for any realistic hope of general disarmament. The effort will apparently be to show, with the frustrating course of the test-ban negotiation as an example, how the Russians talk enthusiastically in general terms of disarmament but, when it comes to specific arrangements, are extremely reluctant to accept any proposal that would limit their freedom of action, even though the acceptance of such limitations is a necessary condition of getting anything done on disarmament. It is apparently in this context, of preparing for the U.N. debate, rather than in a context of preparing for a prompt resumption of testing, that Dean is being sent back to Geneva next week.

In line with this preparation for the U.N. debate, the Administration has apparently decided to press Congress for approval of Kennedy's proposal for an expanded United States Disarmament Agency, rather than let the proposal lie over until the next session when it can be given more leisurely consideration. The Senate Foreign Relations Committee held hearings on the bill this week, and the House Foreign Affairs Committee is expected to follow suit. Except for the Goldwater wing in Congress, which numbers perhaps 10 members in the Senate and perhaps 60 members in the House, there is no real opposition to Kennedy's proposal. Members who are likely to oppose the bill are far outnumbered in both Houses, and if the President insists, as he apparently is doing, that it is important to pass the bill promptly, there seems to be no important obstacle to getting it through. John McCloy, the president's chief adviser on disarmament, met with the Senate Republican policy committee last week; afterwards the Republican leader, Senator Dirksen, announced that he thought most Republicans were "ready to go along with the general

outlines" of the Administration bill and that there was no disagreement among Republicans with the stand that something had to be done to get disarmament on its feet. Representative Halleck, the House leader, has as yet made no public statement, but there is no likelihood that he would oppose the bill.

Needles

On a far simpler matter, the federal Space Council, part of the Executive Office of the President, has issued a report assuring astronomers that the Air Force project to put in orbit a band of fine copper wires will have no significant effect on astronomical observations, and that no larger-scale project will be authorized until the results of the first test can be evaluated, or without consulting with American and foreign astronomers. A mild furor had developed over the project, from the concern of astronomers that the globe-circling belt of wires would interfere with radio and optical astronomical observations.

The project was originally called Project Needles, an apparently too evocative description of the 35 million bits of fine wire that would be put in orbit. Their total weight would be about 75 pounds. The project is now called "West Ford," after the location of the largely Air Force financed M.I.T. Lincoln Laboratory (Westford, Mass.), where the experiment was conceived.

The purpose of the experiment is to seek confirmation of theoretical predictions that such a belt of fine wires, each about 0.7 of an inch long, the proper length to reflect radio frequencies in the 8000-megacycle range, could be used as an artificial ionosphere to make possible long-range communication at such frequencies. Without the belt, long-range communication at ultrahigh frequencies is impossible beyond the horizon, since signals of such short wavelength simply pass through the ionosphere, instead of being reflected back to earth. The two practical advantages that are seen from such a system are that (i) it would broaden the range of frequencies that could be used for long-range communication and so relieve the crowded traffic in the conventional frequencies used for international communication, and (ii) the artificial reflecting band could be a more reliable means of long-range communication than the actual ionosphere, which makes radio communication susceptible to sharp variation and occasionally to

blackouts due to sunspot activity affecting the ionosphere.

The astronomers were concerned that, in addition to reflecting radio waves back to earth, the wire band would reflect radio waves from the stars away from the earth, and so interfere with radio astronomy. To a lesser extent the astronomers were concerned that the band should interfere with optical astronomy. The Space Science Board of the National Academy of Sciences was informed of the project by the Lincoln Laboratory in the fall of 1959 and concluded, after a study completed in June 1960, that the exploratory test would have no harmful effects on any branch of science, since the effect on radio waves from space reaching the earth would be a matter of a very few parts per million, and would be barely detectable, and then only because the astronomers would know just where to look for it. But the Space Science Board also concluded that there was justifiable cause for concern over the effects that might be produced if the much larger band needed for an operational system were put up after a successful pilot experiment.

The NAS Space Science Board generally allayed the astronomers' concern over the pilot test, but left them with their greater concern over the possible harmful effects of a fully operational system. The significance of the Space Council policy statement, which is an official statement of U.S. policy, was that it gave the astronomers the assurance the National Academy could not give, that the government would not authorize the larger follow-up project, or satellite projects generally, without full consideration of the possible side effects of a project on other scientific fields, or without giving interested scientists a chance to make their views felt.—H.M.

A new type of fatty substance—a **phosphate-free plasmalogen**—has been discovered by a group of Harvard chemists. The new substance combines properties of the two main types of lipid substances known—fats and phosphatides. A variant of a phosphatide, in which a fatty acid is replaced by a vinyl alcohol, is known as a plasmalogen. The new substance does not contain phosphorus, and in this it resembles the fats; like the plasmalogens, it contains vinyl alcohol.

The newly discovered lipid occurs in minute amounts and thus has been missed up to now. Beef brain, guinea-pig heart, and beef bone marrow con-

tain, respectively, 3, 15, and 50 parts of the lipid per 10,000 parts of total fatty substance. The Harvard chemists are now trying to determine the possible importance of the lipid in the healthy and diseased organism.

The country's **population center**—defined by the Census Bureau as that point upon which the United States would balance, if it were a rigid plain, without weight, and if the population were evenly distributed and all individuals were of equal weight—has been officially relocated in a field 6½ miles northwest of Centralia, Illinois. The U.S. Coast and Geodetic Survey relocated the center on the basis of last year's national census. Since the first census in 1790, the center of population has moved westward 701 miles from its original point, 23 miles east of Baltimore, Md.

A "research city" is scheduled to be built near Munich, Germany, by 1965. The complex of buildings will house the Munich Institute for Plasma Physics, the Max Planck Society's working group for extraterrestrial research, and a number of other research institutes. Laboratories, offices, private study rooms for individual scientists, a large auditorium, a library, workshops, storehouses, and a power station will be erected in three phases of construction. The West German Ministry for Nuclear Energy estimates the cost of the project at \$20 million. Of this amount the West German government will provide \$17 million; the remaining \$3 million will be contributed by the European Atomic Energy Commission.

The U.S. Post Office has discontinued experiments with high-speed **electronic transmission of mail**, after spending over \$4 million on a test program. In the pilot operation, "facsimile mail" was transmitted by coaxial cable or microwave radio. According to the Post Office, several private firms are conducting similar experiments and the government abandoned the program rather than be in direct competition with them. The test program demonstrated, it was announced last fall, that mail could be moved between Chicago and Washington in 15 seconds.

Students of engineering and of teaching, according to Peiping Radio, constituted more than two-thirds of the 160,000 graduates who were recently awarded diplomas in Red China.

Announcements

The following have been appointed judges for the 1961 **AAAS-Westinghouse Science Writing Awards** [*Science* **133**, 1909 (1961)]:

Walter G. Barlow, president of Opinion Research Corporation, Princeton, N.J.

Norman Cousins, editor of the *Saturday Review*.

Geoffrey Edsall, superintendent of the Institute of Laboratories, Massachusetts Department of Public Health.

Earl English, dean of the University of Missouri's school of journalism.

Ralph E. McGill, editor of the *Atlanta Constitution*.

Morris Meister, president of the Bronx Community College.

Deadline for entries: *10 October 1961*. (Graham DuShane, AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C.)

Russian-speaking physicians, researchers, technicians, and administrators are being sought as participants in the U.S. Information Agency's **medical exhibition in the U.S.S.R.**, scheduled to tour three major cities of the Soviet Union in 1962. (John Dixon, ICS Exhibits Division, U.S. Information Agency, Washington 25)

The Philippines, Malaya, and Thailand have formed the **Association of Southeast Asia (ASA)** "to establish effective machinery for . . . consultation and mutual assistance in economic, social, cultural, scientific, and administrative fields." ASA's goals include exchange of educational and research facilities and information; collaboration in the utilization of natural resources and the improvement of transport and communications; and cooperation in the study of international commodity trade problems.

Scientists traveling to the Soviet Union are invited to use the Information Center for American Travelers to the Soviet Union, 333 East 46 St., New York City. Individuals or groups may contact the center to arrange for a briefing. The center is sponsored by the Government Affairs Institute. The service is free. Information of a more specialized nature is available from the Office of International Relations of the National Academy of Sciences, 2101 Constitution Ave., Washington, D.C. Among other services, the NAS office

will refer scientists to colleagues who have traveled in the Soviet Union and have offered to answer questions raised by prospective travelers.

A report on the National Institutes of Health's **summer institute in biophysical science**, held from 28 August to 9 September 1960 in Cambridge, Massachusetts, has been published by NIH's Biophysics and Biophysical Chemistry Study Section. (Office of the Principal Consultant, BBCSS, 2020 Milvia St., Berkeley 4, Calif.)

The **American Federation of Information Processing Societies** has been formed as the successor body to the National Joint Computer Committee. The founding societies of the federation are the American Institute of Electrical Engineers, the Association of Electrical Engineers, the Association for Computing Machinery, and the Institute of Radio Engineers. The federation will accept into membership "other non-profit corporations and unincorporated associations which meet certain requirements." (Willis H. Ware, Rand Corp., 1700 Main St., Santa Monica, Calif.)

Grants, Fellowships, and Awards

Scholarships at German institutions for research in science and the liberal arts are available to non-German scientists and scholars below the age of 35 through the Alexander von Humboldt Foundation. The scholarships will be granted for 1 year, but may be extended for another year. Beginning 1 January 1962, the foundation will also offer scholarships to lecturers at non-German universities who have conducted teaching and research work for a minimum of 5 years and whose publications are of outstanding merit. Recipients will be provided with round-trip travel expenses and additional family grants. (Humboldt Foundation, German Academy of Sciences, Berlin, W.8)

Fulbright grants are available for **advanced research and university lecturing** during the academic year 1962-63 in Europe, the Near and Middle East, the Far East, and the United Kingdom and its overseas territories. Eligibility requirements are as follows: U.S. citizenship; for lecturing, at least one year of college or university teaching experience; for research, a doctoral degree or recognized professional standing; in some cases, a knowledge

of the language of the host country. Awards are tenable in one country, usually for a full academic year, and payable in the currency of the host country. They provide round-trip travel for the grantee, and, for lecturers going to certain countries of Asia and Africa, round-trip travel for one dependent; a maintenance allowance to cover living costs; an incidental allowance; and, for lecturers in specific countries of Asia and Africa, a supplemental dollar grant. Deadline, *1 October 1961*. (Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., NW, Washington 25)

Physicians who wish to do special work in **nutrition** are eligible for the 1962-63 Nestlé fellowship, sponsored by the French Nestlé Company. Candidates must have a reasonable command of French. (International Children's Centre, Château de Longchamp, Bois de Boulogne, Paris XVI)

Applications are being accepted by the National Academy of Sciences-National Research Council for the James Picker Foundation fellowships and grants in **radiology and nuclear medicine**. Awards are made in four categories.

Advanced fellowships in academic radiology. Candidates, preferably less than 34 years old, must have completed clinical training in radiology and should be prepared to devote at least 2 years to course work in the basic sciences and to application of techniques.

Postdoctoral research fellowships. Preference will be given to candidates with some training in radiology, although persons from closely related disciplines may apply. Applicants must hold the M.D., Ph.D., or Sc.D. degree or the equivalent.

Grants for scholars, offered to assist medical schools in supporting and developing junior staff members in radiology. The application is to be submitted by the institution on behalf of the candidate. A 2-year grant of \$6000 a year will be made to the institution.

Grants-in-aid of research, oriented toward, but not necessarily limited to, diagnostic aspects. The grants are awarded to institutions.

Applications for the fiscal year 1962-63 should be submitted by *1 October*. (Committee on Radiology, National Academy of Sciences-National Research Council, 2101 Constitution Ave., NW, Washington 25, D.C.)

Meeting Notes

The 11th International **Genetic Congress** will be held at The Hague-Scheveningen, Netherlands, 2-12 September 1963. (S. J. Geerts, Genetisch Laboratorium, Driehuizerweg 200, Nijmegen)

Papers and lectures presented during the fourth national **cancer conference**, held in September 1960, are available in a single 774-page volume. (R. N. Grant, American Cancer Society, Research Education Service, 521 W. 57 St., New York 19)

A **marine sciences** conference will be held at Woods Hole, Mass., 11-15 September. It is sponsored jointly by the American Society of Limnology and Oceanography and the Instrument Society of America's marine sciences division.

The first meeting of the **Western Conference of Immunologists** will be held 22-23 January 1962 in La Jolla, California. The organization is designed primarily to meet the needs of immunologists and immunochemists residing west of Centralia, Illinois, but there are no geographical restrictions on membership or attendance. (Hugh Fudenberg, University of California Medical Center, San Francisco)

A panel discussion on **recent developments in European psychiatry** will be held on 27 September at the New York Academy of Medicine. (Association for the Advancement of Psychoanalysis, 329 E. 62 St., New York 21)

A meeting on **operations research and management science** will be held 8-10 November in San Francisco. At this first joint national meeting of the Operations Research Society of America and the Institute of Management Sciences the following subjects will be discussed: mathematical programming; information processing; queuing models; decision theory; operations research and management science in the area of world peace; developments in organization theory; and general systems analysis. (William R. Fair, Fair, Isaac and Co., 156 Montgomery St., San Francisco 4, Calif.)

The first international conference on **oral surgery** will be held at the Royal College, London, 1-4 July 1962. (D. C. Trexler, American Society of Oral Surgeons, 840 N. Lake Shore Dr., Chicago)

Scientists in the News

Nicholaas Bloembergen of Harvard University and **H. E. D. Scovil** of the Bell Telephone Laboratories have been selected by the Franklin Institute to receive the Stuart Ballentine medal "for the invention of the three-level solid-state maser and its subsequent development for practical use."

Robert M. O'Neal, former associate professor of pathology at the Washington University School of Medicine, St. Louis, has been named professor and chairman of the department of pathology at Baylor University College of Medicine.

Frank J. Kreysa, of W. R. Grace and Company, Washington, D.C., has been appointed staff associate for physics, chemistry, and related sciences at the Smithsonian Institution's Science Information Exchange.

M. King Hubbert, consultant in general geology to the Shell Development Company, Houston, Texas, has been named visiting professor of geology and geophysics at Stanford for the winter quarters of the academic years 1961-62 and 1962-63.

Rhodes W. Fairbridge, professor of geology at Columbia, is on sabbatical leave as visiting professor at the Sorbonne, Paris.

Frederick H. Kasten, biologist at the A & M College of Texas, has been named the first Feulgen Memorial Lecturer by the Justus Liebig University of Giessen, Germany.

Frederick T. Hedgcock, associate professor of physics at the University of Ottawa, has been named manager of the Franklin Institute's magnetism and semi-conductor laboratory, Philadelphia.

MacRoy Gasque, of Duke University Medical School's department of preventive medicine, has been named to the newly created position of medical director at Olin Mathieson Chemical Corp.

John K. Clark, former associate professor of medicine at the University of Pennsylvania, has been appointed vice president of research and development at Smith, Kline and French Laboratories.

Hao Wang, reader in the philosophy of mathematics at Oxford University, has been appointed Gordon McKay professor of mathematical logic and applied mathematics at Harvard.

Gustave J. Dammin, member of the faculty of medicine and pathologist-in-chief at the Peter Bent Brigham Hospital, Boston, has been appointed the first Elsie T. Friedman professor of pathology at Harvard University Medical School.

Irving Schulman, professor of pediatrics at Northwestern University Medical School and director of hematology at Children's Memorial Hospital, has been appointed head of the department of pediatrics at the University of Illinois College of Medicine. He succeeds **Heyworth N. Sanford**, who is retiring.

Dragoslav Popovic, professor of nuclear reactor engineering at the University of Belgrade, has been appointed director of the International Atomic Energy Agency's Safeguards Division.

Joseph M. Foley, professor of neurology at Seton Hall University College of Medicine and Dentistry, has been appointed professor and director of the division of neurology at Western Reserve University's School of Medicine.

Hilton A. Smith, professor of chemistry at the University of Tennessee, has been appointed dean of the university's graduate school and coordinator of research, effective 1 September.

Alfred Lit, formerly with Bendix Systems Division, Ann Arbor, Michigan, has been appointed professor of psychology at Southern Illinois University.

Aaron Seamster, chairman of the department of biology, Northeast Louisiana State College, has been appointed dean of the division of pure and applied science. He will be succeeded as department chairman by **B. Earl Price**, associate professor of biology.

Joy B. Phillips, associate professor of zoology at Drew University, has received Sigma Delta Epsilon's first grant-in-aid for research by a woman.

Roger E. Batzel, nuclear chemist and associate director of the University of California's Livermore Laboratory, has been appointed acting associate direc-

tor for testing at the university's Lawrence Radiation Laboratory. He succeeds **Gerald W. Johnson**, who has been appointed chairman of the Atomic Energy Commission's Military Liaison Committee and assistant to the Secretary of Defense for atomic energy.

John T. Norton, dean of the graduate school and professor of physics at Massachusetts Institute of Technology, has received the Plansee plaque, awarded triennially by the International Plansee Society for Powder Metallurgy. He is the first American to receive the award.

Richard H. Bohning, assistant dean of Ohio State University's College of Agriculture and Home Economics, will direct the training of 36 Peace Corps volunteers, of whom 25 will be selected to serve in India in the Punjab.

Leo P. Vernon, on sabbatical leave from his post as professor of chemistry at Brigham Young University, has been appointed director of research at the Charles F. Kettering Laboratory, Yellow Springs, Ohio, effective 1 October.

William F. Bradley, professor and specialist in chemical crystallography and mineralogy at the University of Illinois, has been appointed professor of chemical engineering at the University of Texas.

Willard H. Bennett, head of the Atomic Physics Branch of the Naval Research Laboratory, has been named Burlington professor of physics at North Carolina State College.

John Thomas, associate professor of internal medicine at Meharry Medical College, has been appointed research collaborator in Brookhaven National Laboratory's medical department, under a program which provides facilities and funds for guest scientists.

William H. R. Shaw, associate professor of chemistry at the University of Texas, will become head of the University of Georgia's chemistry department on 1 September. He succeeds **Alfred E. Scott**, who is retiring.

Erratum: In "Scientists in the news" [134, 321 (4 Aug. 1961)] David Glick was erroneously reported to have been appointed head of the pathology department at Stanford University Medical School. Glick was named professor of pathology and head of the division of histochemistry in the pathology department. Alvin J. Cox is head of the department.

Book Reviews

Reconnaissance of Outer Space

The Hubble Atlas of Galaxies. Allan Sandage. Carnegie Institution of Washington, Washington, D.C., 1961. viii + 32 pp. Illus. + 50 plates. \$10.

Astronomy is an observational science, not an experimental one. We cannot change the temperature of a star by a chosen amount in order to discover the nature of the resulting change in the spectrum. We can only observe the spectra of different stars that have differing temperatures, and we can watch the concomitant changes in the spectra and temperatures of pulsating stars. We cannot even watch evolutionary changes in stars and galaxies take place; the time scale is too long.

The Hubble Atlas of Galaxies is a major contribution to the observational study of cosmology. Any acceptable theory of the origin and evolution of galaxies must be capable of explaining the large variety of observed forms and stellar content found among these objects. The classical presentation of this subject may be found in chapter 2 of Hubble's book *The Realm of the Nebulae*, first published in 1936 and now available in a Dover paperback edition (1958).

Allan Sandage has written an excellent introduction to the atlas, but Hubble's earlier book is still well worth rereading. Many readers of this review, and even some of the users of the new atlas, may not be familiar with the evolution of the terminology used in this subject. Some quotations from Hubble's book may be helpful here:

"The astronomical term *nebulae* has come down through the centuries as the name for permanent, cloudy patches in the sky that are beyond the limits of the solar system. The interpretation of these objects has frequently changed, but the name has persisted. . . .

"Today, the term *nebulae* is used for two quite different kinds of astronomical bodies. On the one hand are the clouds of dust and gas, numbering a few score in all, which are scattered

among the stars of the galactic system. These have been called *galactic nebulae*. On the other hand are the remaining objects, numbering many millions, which are now recognized as independent stellar systems scattered through space beyond the limits of the galactic system. These have been called *extragalactic nebulae*. The nomenclature is followed in this book with the exception that, since extragalactic nebulae are mentioned so frequently, the adjective will be dropped. Therefore the term *nebulae* will refer to extragalactic nebulae alone, unless otherwise specified.

"Some astronomers consider that since nebulae are now known to be stellar systems they should be designated by some other name, which does not carry the connotation of clouds or mist. Such a revision might be useful, but, as yet, no entirely suitable alternative name has been suggested. The proposal most frequently discussed is a revival of the term *external galaxies*.

"... Usage, however, is not always determined by logic. The established definition may be dropped and the variant, revived, may flourish. No prediction is ventured. The term *nebulae* offers the values of tradition; the term *galaxies*, the glamour of romance."

The title of the new atlas shows that tradition lost out here, and rightly so.

The introductory material Sandage wrote for the atlas consists of a preface and 32 additional pages of historical and descriptive material. The historical discussion begins with the island-universe speculations of Kant (1724-1804), Swedenborg (1688-1772), and Wright (1711-1786) and includes a description of the work of Shapley, Curtis, and Lundmark during the period 1917 to 1921. Sandage's description and evaluation of the conflict between Shapley and Curtis, which culminated in the historic debate held before the National Academy of Sciences on 26 April 1920, is objective and fair. Sandage continues:

"Clearly neither side had convinced the other. New data were needed to place the solution beyond all doubt. Edwin Hubble provided these crucial

data by his discovery, analysis, and interpretation of cepheid variable stars in M31, M33, and NGC 6822. This discovery settled the controversy once and for all. It proved beyond question that nebulae were external galaxies of dimensions comparable to our own. It opened the last frontier of astronomy, and gave, for the first time, the correct conceptual view of the universe. Galaxies are the units of matter that define the granular structure of the universe itself."

Hubble was working on the preparation of an atlas such as this one at the time of his death in September 1953. The work had not progressed to the point where a simple editorial job was all that was needed to finish the work. Sandage states:

"I have acted mainly as an editor, not an editor of a manuscript but rather an editor of a set of ideas and conclusions that were implicit in the notes, in Hubble's grouping of galaxies into lists, in his notations on plate envelopes, and in conversations with him from 1949 to 1953, and in the scheme as it emerged from inspection of the same material that he had used to define his system."

To me this seems to be too modest an evaluation of Sandage's contribution. There are 186 photographs of 176 different galaxies reproduced here; Sandage, himself, took one-third of the photographs. Hubble took 72, Sandage 63, Milton Humason 24, and seven others were responsible for the rest.

The atlas is very conveniently organized. A table of data lists the galaxies in order of their NGC (*New General Catalogue of Nebulae and Clusters of Stars*) number and gives the type of the galaxy, the telescope used, the atlas page, the enlargement of the picture, and the scale of the picture in seconds of arc per millimeter. The arrangement of the photographs is by class in the order Elliptical (E), Normal Spirals (S), Irregular (Irr.), and Barred Spirals (SB). Descriptive material for each photograph is printed on a page facing the photograph. The halftone reproductions are of excellent quality, and I did not realize they were halftones until I inspected them with a pocket magnifier.

Allan Sandage and the Carnegie Institution of Washington deserve the gratitude of astronomers, cosmologists, and all who have esthetic appreciation for fine astronomical photographs.

FRANK K. EDMONDSON
*Goethe Link Observatory,
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Animals and Habitat

Living Amphibians of the World. Doris M. Cochran. Doubleday, Garden City, N.Y., 1961. 199 pp. Illus. \$12.50.

Doubleday Pictorial Library of Nature. Earth, plants, and animals. Josephine Perry, Ed. Doubleday, Garden City, N.Y., 1961. 363 pp. Illus. \$9.95.

These handsomely printed, lavishly illustrated books complete their respective seven- and two-volume series. Both are intended for an international audience of youngsters and oldsters who wish to counteract the trend toward extreme specialization by considering the natural world as a living, dynamic whole. The volume on amphibians is concerned with closely related topics and consequently shows fuller coverage and permits a chattier style. The volume on earth, plants, and animals is necessarily more encyclopedic in organization, and it often relies upon the sort of coordination and more informed reading a parent can give in achieving a satisfying explanation from the use of illustrations and text. The two books complement one another and seldom overlap.

Doris Cochran's book, like others in the "World of Nature Series," follows an inconspicuous taxonomic framework to introduce lively accounts of both the commonly encountered and the more unusual members of each amphibian family. It indicates where in the world they are found and how they fit their particular habitats. Abundant color plates of very high quality add to the appreciation. Readers can use the book for repeated reference, via its good index, or they can enjoy reading page after page, sharing the author's enthusiasm for her subjects. Pertinent comments are included on the role of amphibians in the food webs and on ways to keep amphibians under continued observation as pets. A need for further information is emphasized in many places; perhaps this will lead to fresh field observations in various parts of the world.

The book edited by Josephine Perry neatly gets the universe into shape; establishes the earth; populates it with life; modifies it through volcanic, mountain-building, and erosive action; and then accounts for the formation of almost everything from subterranean anthracite to coral atolls in 48 pages—surely a record for despatch! Biology is well integrated in the following 240

pages, followed by a 28-page taxonomic summary of the plant and animal kingdoms and a 14-page glossary. Particularly full coverage is accorded evolution, animal behavior, biogeography, and the development of human culture. The style varies somewhat from subject to subject, reflecting differences among the nine contributing authors. But always the material reads easily and is extraordinarily informative for so brief a presentation. Most of the topics are tailored to fit on one or two facing pages, under a helpful subhead.

LORUS MILNE
MARGERY MILNE

Graduate Summer School,
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Tribute to Jeffreys

The Earth Today. A. H. Cook and T. F. Gaskell, Eds. Royal Astronomical Society, London, 1961 (order from Oliver and Boyd, Edinburgh; Interscience, New York). xii + 404 pp. Illus. \$13.

The Earth Today, a special issue of the *Geophysical Journal* (vol. 4) dedicated to Sir Harold Jeffreys on the occasion of his 70th birthday, contains a statement by the editors, an appreciation of Jeffreys' work by Robert Stoneley, and 27 papers by an international group of contributors. It is especially appropriate that the editors of the *Journal* have honored Jeffreys in this way; the *Geophysical Journal* is the successor to the *Geophysical Supplement* of the Royal Astronomical Society, of which Jeffreys was for many years editor and one of the principal luminaries. In both phases this journal is rightly recognized as the outstanding journal of theoretical geophysics.

As the title suggests, this volume is intended to contain the latest discussions of topics covered in Jeffreys' great book, *The Earth*, now in its fourth edition (1959). Five papers deal with aspects of gravitation and geodesy, including the derivation of the Earth's potential from observation of satellite orbits; 12 are concerned with seismology and global oscillations; three with thermal matters, including new data on heat flow in the Atlantic. Virtually all of the topics have at one time or other been the subject of investigation by Jeffreys himself. The present intense activity in geophysics is demonstrated

by the ease with which this and other special volumes, such as those dedicated to Vening Meinesz and Gutenberg, have been filled with new articles, with no visible reduction in the rate of expansion of the regular journals and reviews.

Aside from the common subject, however, nothing could be less like *The Earth* than *The Earth Today*. Jeffreys' treatise, with its various revisions, has provided a coherent synthesis of a large fraction of geophysical theory and fact, sifted by a single intellect, and presented with a consistent point of view; in large measure, this was possible only because Jeffreys had made original contributions in every subject treated in *The Earth*. It is a book in which the impress of Jeffreys' mind and personality appears on every page. Thus it differs radically from the undigested compilations of bits and pieces so often found between hard covers as well as from the individual research papers collected here.

The Earth Today is about the same size as the fourth edition of *The Earth*, but it represents a small part of this year's publication in the relevant topics. One can only wonder whether Jeffreys' feat of synthesis can ever be repeated with the same success.

FRANCIS BIRCH

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Tropical Flora

Native Orchids of Trinidad and Tobago.

Richard Evans Schultes. Pergamon, New York, 1960. x + 275 pp. Illus. \$15.

The Native Orchids of Trinidad and Tobago is a part of a series on the flora of the colony which is being published family by family. The Orchidaceae on the two islands, represented by 181 species distributed among 66 genera, is the second largest family represented in the flora; it is slightly surpassed by the Gramineae with 183 species. In this colony, as in other areas of tropical America, the orchids have attracted several devoted amateur collectors and growers over the years and, for this reason, may be better known and more thoroughly collected, relatively, than the grasses.

The volume is divided into two parts. Three short chapters cover general con-

siderations of the orchid family, orchids and their collectors, and acknowledgments. This is followed by the systematic section of the volume, which takes up all but 18 pages of the total.

The systematic section is excellent. The treatment of both the genera and the species is conservative. The account of a given genus includes a description of the genus; a key to the included species, if more than one; the accepted specific name, and synonyms for a much greater area than that covered by the volume; a specific description; flowering times; range of the species (Mexico is sometimes included in the term "Middle America," but more often given separately). The exsiccatae for Trinidad and Tobago are cited.

The illustrations are mostly excellent and very much more numerous than the "List of plates" would indicate—there are 97 plates although only 21 are mentioned. One photograph, by oversight, is used to illustrate species in different genera (opposite pages 70 and 78, where the illustrations belong with the *Pleurothallis*).

The volume can be recommended not only as a source of information on the flora of Trinidad and Tobago but also for the large number of plates illustrating plants of a much wider range. The volume is well and attractively printed on paper that appears to be of excellent quality. The price is rather high even considering the number of plates.

LOUIS O. WILLIAMS
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Language's Role in Behavior

Language and the Discovery of Reality. A developmental psychology of cognition. Joseph Church. Random House, New York, 1961. xviii + 245 pp. Illus. \$4.

Whatever their current research activities might suggest, many psychologists would profess their ultimate goal to be that of arriving at a satisfactory scientific account of such "higher mental processes" as classifying, thinking, and problem solving. There is today renewed interest in what has been called "cognitive psychology" and in speech, language, and communication. To mention some of the more prominent approaches within psychology, we have B. F. Skinner's uncompromising

attempt to describe verbal behavior in terms of the principles of reinforcement, G. A. Miller's treatment of language in terms of information theory, and C. E. Osgood's use of a "mediation hypothesis" to explain the acquisition of meaning. From the fields of linguistics and cultural anthropology we have had a description of language as a formal system of meaningful sounds and the hypothesis—most closely associated with the name of B. L. Whorf—that the particular language one is brought up to speak conditions one's perception of objective reality and perhaps also one's modes of thinking.

Church's important contribution in this book is his clear formulation of a self-consistent, no-nonsense point of view concerning the role of language in behavior, derived largely from an analysis of the development of the child's use of language in relation to his perceptual and cognitive experiences. Arguing from a phenomenological base, Church states his opposition to what he regards as the gratuitous constructions of Skinner and also to the mystique of Whorf's linguistic relativity. He believes that the influence of language categories upon the child's awareness of reality is only indirect, but still traceable.

A substantial portion of the book is devoted to issues which are not immediately related to the theme advertised in the title but which are valuable and interesting as rightful subject-matter in cognitive psychology: the preverbal experience of the child, the "thematization" of experience, "upward" and "downward" logical classifications, varieties of thinking, tests of verbal functioning, and the nature of personal styles of thinking and acting.

The book is well organized and gracefully written. Church keeps much of his documentation and evidence behind the scenes; in his allusions to observations made of children, for example, he fails to identify the observers, the conditions of observation, the status of the children, and so forth. The reader has little opportunity to question the interpretations offered by Church. This is nonetheless a significant and provocative book, containing much insight and wisdom for psychology as a whole and many suggestions not only for research but also for the conduct of education.

JOHN B. CARROLL
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Carus Mathematical Series

Statistical Independence in Probability, Analysis and Number Theory (Carus Mathematical Monographs, No. 12). Mark Kac. Wiley, New York, 1959. xiv + 93 pp. \$3.

This book is an outgrowth of three lectures delivered by Mark Kac at the summer meeting (1955) of the Mathematical Association of America; the general topic was "Familiar things from an unfamiliar point of view." Subsequently Kac was invited to prepare an expanded version for publication in the Association's Carus Mathematical Monograph Series, the aim of which is "to contribute to the dissemination of mathematical knowledge by making accessible . . . expository presentations of the best thoughts and keenest researches in pure and applied mathematics . . . set forth in a manner comprehensible not only to teachers and students specializing in mathematics, but also to scientific workers in other fields. . . ." Kac has made a signal contribution in this direction.

The concept of *statistical independence* stems from the commonplace notion of two or more things (events, propositions, and the like) being independent if they have "absolutely no connection with each other whatsoever." The concept of *probability* itself was long surrounded "with vagueness which bred suspicion as to its being a bona fide mathematical notion." Today both *probability* and *statistical independence* are precisely defined but in very general and abstract terms. The price of such generality and abstraction is "not only to submerge the simplicity of the underlying idea but also to obscure the possibility of applying probabilistic ideas and results outside of the field of probability theory."

The author's principal aim in the original lectures and in this enlarged version was to show that "(a) extremely simple observations are often the starting point of rich and fruitful theories, and (b) many seemingly unrelated developments are in reality variations on the same theme." In view of the aim stated in (a) perhaps one should not be surprised to find that the book starts with the formula

$$\sin x = 2 \sin \frac{x}{2} \cos \frac{x}{2}$$

The chapters "The normal law in number theory" and "From kinetic theory

to continued fractions" fulfill objective (b). Over and over again Kac exemplifies the old Italian saying: "A mathematician is like a lover—grant a mathematician the least concession and he will draw from it a consequence, and from that consequence another!"

A truly delightful book!

CHURCHILL EISENHART

National Bureau of Standards

Forerunner of Audubon

Mark Catesby. George Frick and Raymond Phineas Stearns. University of Illinois Press, Urbana, 1961. x + 137 pp. Illus. \$5.

If Audubon—Bartram—Catesby are the ABC's of American natural history, Catesby is certainly least known to Americans. This attractive book will help remedy that situation, but we shall not know Catesby well until his great work, *Natural History of Carolina, Florida, and the Bahama Islands*, is reissued.

Eighteenth-century Catesby, subsidized by Sloane, Sherard, and others who had been eager for the contributions of John Banister, and by Governor Nicholson, displayed none of Audubon's showmanship as man or artist. Catesby illustrated North American birds in habitat backgrounds, a method brought to its fullest flowering by Audubon in the next century. Contrary to the authors, these backgrounds were not initiated by Catesby. Maria Sibylle Merian published her first work in 1679, and another on insects of Surinam in 1705, wherein plants fairly compete with insects in disciplined beauty.

We know little of Catesby's exact routes in Virginia and Carolina. He reached Fort Moore on the Savannah River some 300 miles from Charleston. There may be notes as to where the sketches were made on the original Catesby drawings in the Royal Library at Windsor. Catesby drew from the living plant, but faced with engraving costs, he took lessons from the French artist, Joseph Goupy, and engraved the plates himself. That Goupy's friend, the Duke of Chandos, was also Catesby's patron seems to have been overlooked. Although the text of his *Natural History* was published in parallel English and French columns, we do not know who prepared the French

version, but the Franco-Philadelphia naturalist Du Simitiere left a 16-page manuscript subject "Catalogue" to Catesby's work, though there is no clear evidence he was in touch with Catesby.

Frick and Stearns' volume is an excellent chronicle of man and naturalist, and happily the price is most attractive! It must be said, however, that this is historians' and not naturalists' commentary. The naturalists' edition, which should be published, will embrace not only bird commentary but also notes on Catesby's mollusks (by Wilkins) and on his plants (by Dandy); it will align these subjects with the state of our knowledge rather more intimately.

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New Books

Mathematics, Physical Sciences, and Engineering

The Abundance of the Elements. Lawrence H. Aller. Interscience, New York, 1961. 294 pp. Illus. \$10.

Algebra. With applications to business and economics. Paul H. Daus and William Whyburn. Addison-Wesley, Reading, Mass., 1961. 365 pp. Illus. \$6.75.

Elementary Particles. Enrico Fermi. Yale Univ. Press, New Haven, Conn., 1961. 120 pp. Illus. \$1.45.

Elements of Statistics. Elmer B. Mode. Prentice-Hall, New York, ed. 3, 1961. 334 pp. Illus. Text edition, \$7.25; trade edition, \$9.65.

Engineering Castings. How to use, make, design and buy them. Glenn J. Cook. McGraw-Hill, New York, 1961. 266 pp. Illus. \$8.50.

Fast Reactors. R. G. Palmer and A. Platt. Temple Press, London, 1961 (order from Simmons-Boardman, New York). 93 pp. Illus. \$2.95.

Flow of Fluids through Porous Materials. Royal Eugene Collins. Reinhold, New York, 1961. 280 pp. Illus. \$12.50.

Heterocyclic Compounds. Polycyclic compounds containing two hetero atoms in different rings. Five- and six-membered heterocycles containing three hetero atoms and their benzo derivatives. vol. 7. Robert C. Elderfield, Ed. Wiley, New York, 1961. 885 pp. Illus. \$37.50.

The Impact of the New Physics. Frank Hinman. Philosophical Library, New York, 1961. 174 pp. Illus. \$4.50.

Instrumentation for High-Energy Physics. Proceedings of an international conference. Lawrence Radiation Laboratory, University of California, Berkeley. Interscience, New York, 1961. 338 pp. Illus. \$10.

Introduction to Engineering Mechanics. John V. Huddleston. Addison-Wesley, Reading, Mass., 1961. 500 pp. Illus. \$9.75.

Introduction to Geometry. H. S. M. Coxeter. Wiley, New York, 1961. 458 pp. Illus. \$9.95.

Modern Computing Methods. Philosophical Library, New York, ed. 2, 1961. 176 pp. Illus. \$6.

Nuclear Sizes. L. R. B. Elton. Oxford Univ. Press, London, 1961. 114 pp. Illus. \$2.40.

Operational Electricity. Theory, characteristics, applications, and mode of operation of circuits and machines. Charles I. Hubert. Wiley, New York. 540 pp. Illus. \$8.50.

Physical Chemistry. Gordon M. Barrow. McGraw-Hill, New York, 1961. 707 pp. Illus. \$8.95.

Plasmas and Controlled Fusion. David J. Rose and Melville Clark, Jr. M.I.T. Press and Wiley, New York, 1961. 507 pp. Illus. \$10.75.

Plastics in Nuclear Engineering. James O. Turner. Reinhold, New York; Chapman and Hall, London, 1961. 149 pp. Illus. \$5.50.

Pleistocene Geology of the Randall Region, Central Minnesota. Allan F. Schneider. Univ. of Minnesota Press, Minneapolis, 1961. 166 pp. Illus. \$4.25.

Probability. A first course. Frederick Mosteller, Robert E. K. Rourke, and George B. Thomas, Jr. Addison-Wesley, Reading, Mass., 1961. 334 pp. Illus. \$5.

Probability with Statistical Applications. Frederick Mosteller, Robert E. K. Rourke, and George B. Thomas, Jr. Addison-Wesley, Reading, Mass., 1961. 493 pp. Illus. + plates. \$6.50.

Progress in Solid Mechanics. vol. 2. I. N. Sneddon and R. Hill, Eds. North-Holland, Amsterdam, Netherlands; Interscience, New York, 1961. 342 pp. Illus. \$11.75.

Quantum Theory. D. R. Bates, Ed. Academic Press, New York, 1961. 462 pp. Illus. \$10.

Radioactive Wastes. Their treatment and disposal. J. C. Collins, Ed. Wiley, New York, 1960. 260 pp. Illus. + plates. \$8.

The Science of Adhesive Joints. J. J. Bickerman. Academic Press, New York, 1961. 266 pp. Illus. \$8.

A Synopsis of Physics. C. C. N. Vass, Ed. Williams and Wilkins, Baltimore, Md., ed. 5, 1961. 348 pp. Illus. \$8.

The Theory of Crystal Structure Analysis. A. I. Kitaigorodskii. Translated from the Russian by David and Katherine Harker. Consultants Bureau, New York, 1961. 286 pp. Illus. \$12.50.

The Theory of Subsonic Plane Flow. L. C. Woods. Cambridge Univ. Press, New York, 1961. 616 pp. Illus. \$22.50.

Thermoelectricity. Science and engineering. Robert R. Heikes and Roland W. Ure, Jr. Interscience, New York, 1961. 587 pp. Illus. \$18.50.

Trace Elements in Plants. Walter Stiles. Cambridge Univ. Press, New York, ed. 3, 1961. 264 pp. \$7.50.

Transistors and Active Circuits. John G. Linvill and James F. Gibbons. McGraw-Hill, New York, 1961. 530 pp. Illus. \$14.50.

Water Treatment. For industrial and other uses. Eskel Nordell. Reinhold, New York; Chapman and Hall, London, ed. 2, 1961. 607 pp. Illus. \$12.

Reports

Host Alternation of Spruce Broom Rust

Abstract. Repeated inoculations demonstrate that *Peridermium coloradense* A. & K. is the gametophytic stage of *Chrysomyxa arctostaphyli* Diet., previous reports notwithstanding. Thus *C. arctostaphyli* is eliminated as the only familiar exception to Transhel's law, which may apply universally to microcyclic rusts.

Peridermium coloradense on spruce (*Picea*) has long been considered conspecific with *Melampsorella caryophyllacearum* Schroet., which alternates between fir (*Abies*) and Caryophyllaceae. Evidence that these rusts are identical consists largely of the inoculation results of Weir and Hubert (1, 2), but these have never been fully confirmed. Pady and others have questioned conspecificity because of differences in morphology and distribution of the spruce and fir rusts (3). The most striking argument against synonymy of these names was that of Hunter (4), who compared pycnia of the two conifer rusts and concluded, regarding the spruce parasite, that "its type is that of a *Chrysomyxa*."

Association of decay and mortality with rust witches' brooms in species of western American spruce has called the attention of U.S. Forest Service pathologists to *Peridermium coloradense*. Classification of the rust and determination of its telial hosts are natural first stages of investigation.

Accordingly, on 29 July 1960, aecio-

spores from a broom on *Picea engelmanni* (collected at Allenspark, Colorado, 28 July) were applied to both surfaces of moistened leaves of 16 caryophyllaceous and 7 ericaceous plants, as follows: ten *Stellaria media*, two *S. longipes*, two *Cerastium vulgatum*, two *Arenaria lateriflora*, two *Arctostaphylos uva-ursi*, one *Chimaphila umbellata*, three *Vaccinium scoparium*, and one *Kalmia polifolia*. An equal number of controls of each species was treated with water only. The potted plants were kept in a greenhouse inoculation chamber in Fort Collins, Colo., for 80 hr (at 100 percent relative humidity, 16° to 28°C), then on a greenhouse bench. After 15 days, the bearberry (*Arctostaphylos uva-ursi*) leaves developed abundant red spots; after 25 days, a careful check of all plants showed no disease symptoms in any except the bearberries, nor in any control plants. Microscopic examination showed that the red spots were the centers of dense rust mycelia.

The bearberries were wilding transplants. They had been in the greenhouse and rust free for 10 mo previous to the experiment; most of their leaves were greenhouse grown.

No sori developed on one infected plant kept in the greenhouse. The other inoculated bearberry was kept outdoors from 2 October until 7 November and then returned to the greenhouse; scores of recognizable telia were produced on it by 28 November (but none on an accompanying control plant). Basidia were not produced until the plant was exposed to 100 percent relative humidity (on 20 December 1960). The teliospores measured 8 to 17 by 16 to 47 μ and the basidiospores 8 to 9 by 9 to 10 μ ; both were characteristic of *Chrysomyxa arctostaphyli* in shape, color, and wall thickness. Bearberry rust is not known within 20 miles of Fort Collins, and though it occurs in the mountains to the west, presumably its natural sporulation was completed

weeks before inoculations were made; contamination thus seemed very unlikely. However, confirming experiments were undertaken. Aeciospores collected in South Dakota on *Picea glauca* were applied to another bearberry plant in the greenhouse; infection (judged by production of mycelium) was abundant, whereas the control was negative. Five series of inoculations were made from 2 August to 6 December 1960 on detached leaves floating on water in petri dishes. In the first series, aeciospores were applied to 41 leaves of *Chimaphila*, *Vaccinium*, *Pyrola*, and *Stellaria*, as well as to eight *Arctostaphylos* leaves; all 41 and their 32 control leaves remained healthy. Eight uninoculated bearberry leaves and four leaves to which aeciospores were applied on the upper epidermis showed no infection. All four bearberry leaves inoculated on the lower epidermis became heavily infected, as judged by production of mycelium. In the second experiment, *Peridermium coloradense* aeciospores from six different collections were used. Only two caused abundant infection (from Allenspark, Colo., and Deerfield, S.D.); concurrent tests on slides showed that only in these two was there measurable aeciospore germination. Of the four nonviable or slightly viable collections, only one gave rise to two red spots on a bearberry leaf, and no mycelium was observed in two hand sections from these spots. As in the first experiment with detached leaves, no infection occurred where spores were applied only to the upper epidermis—probably because no stomata occur there. Later inoculations on newly expanded bearberry leaves in petri dishes were designed to test light and temperature requirements for infection. All these experiments confirmed the spruce-bearberry alternation in that they gave rise to rust mycelium from broom rust aeciospores under some conditions, and all control leaves remained healthy.

These experiments demonstrate that *Peridermium coloradense* is the aecial stage of a rust which appears to be identical with *Chrysomyxa arctostaphyli*. In retrospect this finding is not surprising. *Peridermium coloradense* "cannot possibly be a *Melampsorella*" (4), and *Chrysomyxa arctostaphyli* without a spruce stage was abnormal among *Chrysomyxae*. The bearberry rust has about the same known range as spruce broom rust, from Alaska and Utah eastward almost to the Atlantic.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should not repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to one 2-column figure (that is, a figure whose width equals two columns of text) or to one 2-column table or to two 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to contributors" [*Science* 125, 16 (1957)].

Where one host is present without the other, as in Greenland, arctic Alaska, and the southern Appalachians, neither rust has been reported. A possible exception is the Kaibab Plateau of north-western Arizona, where *Peridermium coloradense* is abundant on spruce but bearberry has not been reported. It will be interesting to see whether another *Arctostaphylos* species serves as host, or the broom rust is short-cycling on spruce, or bearberry is actually present. *Peridermium coloradense* has been reported southward to central Mexico (5), far beyond the range of bearberry, but probably this is erroneous because central Mexico is also far south of the spruce host's range. In Eurasia both hosts are present, but both rusts are absent, according to mycological works on that area.

The bearberry *Chrysomyxa*, though called microcyclic (2), is on the "wrong" host to be so according to Transhel's law, which is (in part) that microcyclic rusts occur on the aecial hosts of related macrocyclic species (6). The aecial hosts of *Chrysomyxa* are *Picea* species, not *Ericaceae*. No evidence was ever presented that *Chrysomyxa arctostaphyli* is microcyclic; it was simply stated to be so. It provided the principal apparent exception to Transhel's generalization (6). Because the telia produced on bearberry from inoculation with *Peridermium coloradense* are identical with those of *Chrysomyxa arctostaphyli*, we can now assume that the latter is not a microcyclic species. Other possible exceptions are also species of *Chrysomyxa*, and are even less known than bearberry rust; quite likely they too are host-alternating. The "law" may apply to all microcyclic rusts.

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13 April 1961

18 AUGUST 1961

Preference Factors in:

Experimental Alcoholism

Abstract. Normal rats which refused 5- and 20-percent alcohol in a previous study were restricted to 5-percent and 20-percent solutions in their home cages for either 30 or 120 days. Differential preferences for alcohol solutions of up to 8-percent were established as a function of length of time animals consumed alcohol but not as a function of the particular concentration consumed prior to testing.

One of the principal experimental procedures in physiological studies of alcohol consumption is the voluntary self-selection method. By daily increasing the percentage concentration of alcohol, Richter and Campbell (1) have shown that rats preferred alcohol over water in ranges of from 1.4 to 6.5 percent. Myers (2), however, found that rats which had never been exposed to alcohol refused a 5-percent solution and would not select this concentration in preference to water; this preference was reversed only when the rats were restricted to alcohol for at least 10 days. From this and other evidence (3), it seems that in Richter's experiments the gradual increases in concentration of alcohol modified the animals' preference threshold.

In order to clarify the role of the time and concentration factors in self-selection, 16 male, 300-day-old hooded rats of the Colgate strain were trained in boxes containing three levers (4) to obtain with each respective lever press a pellet of food, 0.03 ml of water, or 0.03 ml of 5-percent alcohol in one apparatus or 20-percent alcohol in the other (5). Each animal was deprived of food and alcohol for 24 hours, and during the 1-hour test session obtained its only food and fluid until the next day at the same time. In all cases the rats preferred water to both concentrations of alcohol throughout the 12 consecutive test sessions. Therefore, the rats were divided into four equal groups so that fluid intakes in their home cages were restricted to 5-percent alcohol for either 30 or 120 days, or 20-percent alcohol for 30 or 120 days. During this time they were maintained on their normal free-feeding laboratory food regimen. Retesting was then carried out, with half of the rats in each of the groups offered alcohol solutions which were increased from 5-percent, in 1-percent steps on successive daily test sessions, and the other half offered alcohol that was decreased from 15-percent concentrations in the same manner. As in

previous research (2) the data showed that food responses (intake) were identical across all groups.

With respect to fluid preference as a function of the two alcohol concentrations in the home cages, there were no differences between the preference curves of rats that consumed 5-percent solutions and those that drank 20-percent solutions. The data from these two groups therefore were combined.

Figure 2 illustrates the preference functions based on the effects of increasing versus decreasing the order of alcohol concentrations offered during testing. Neither the 30- nor the 120-day group on the decreasing alcohol schedule manifested a clear-cut preference for alcohol until the concentration dropped to 4 percent (bottom graph). This is in sharp contrast to the preferences for higher alcohol concentrations by the groups offered alcohol increasing in concentration by 1 percent each day (top graph). Here it is postulated that the water preferred during the 9-day period in which the alcohol concentrations were high and in the aversive range reduced the acclimation to and counteracted the effects of the long-term drinking.

In Fig. 2 an over-all comparison of water and alcohol response functions, independent of the increasing or decreasing order, clearly shows that in the 30-day groups a shift in preference from alcohol to water occurs more

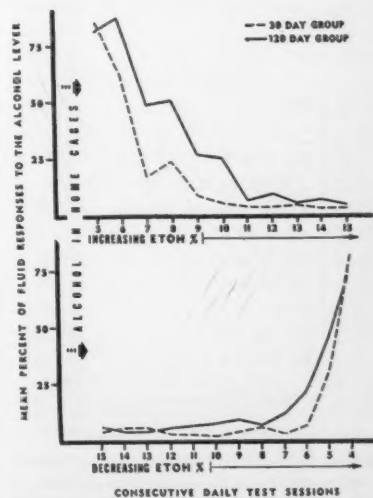


Fig. 1. Comparison of the two testing methods for offering alcohol solutions to both 30- and 120-day groups of rats. On successive days, the alcohol solution was increased by 1-percent steps (top) or decreased by 1-percent steps (bottom).

rapidly and at a significantly lower percent than in the 120-day groups ($P < .01$). Thus it may be concluded that although the home cage concentration of alcohol solution prior to testing did not seem to be significant in these tests, two important factors did influence the change in preference for alcohol: (i) the amount of time spent drinking prior to testing, and (ii) occurrence of an interval when water was ingested while alcohol was in the gustatorily noxious range.

Finally, in view of these and other data, it is apparent that the arbitrary selection of a predetermined alcohol solution, such as the commonly used 10-percent concentration (6), is a questionable procedure for studying those experimental variables affecting the preference of this substance. Attributing animals' refusal of 10-percent solution to some physiological condition or alteration may be entirely erroneous, since this concentration simply could be above the normal organism's maximum preference level (refer again to Figs. 1 and 2).

In investigations which utilize preference for alcohol (and probably other substances) as a main experimental effect, the following factors must be considered: (i) acclimation period or prior exposure to the substance; (ii) the preference threshold for the specific genetic strain of individual animals under investigation (7); (iii) the nutritional and metabolic states of the organisms (8); and (iv) technical details,

including cage position of the available substance and possible stress conditions (9). Neglect of any or all of these factors could seriously affect the validity of the research (10).

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15 May 1961

Suppressor of Pyrimidine 3 Mutants of *Neurospora* and Its Relation to Arginine Synthesis

Abstract. The basis of the mutant phenotype of the *pyr 3a* strain of *Neurospora* appears to be the arginine sensitivity of an early step in pyrimidine synthesis. The effect of a suppressor mutation which renders *pyr 3a* pyrimidine-independent is to reduce arginine levels in the mycelium by its effect on ornithine transcarbamylase.

The *pyr 3* locus of *Neurospora* is represented by a number of independent mutations which impose a pyrimidine requirement upon the organism. It has been found that a group of mutants represented by *pyr 3d* (45502) lacks the enzyme aspartic transcarbamylase (ATC) (1) and does not respond to the presence in the same genome of an unlinked suppressor mutation, *s* (2). The mutants represented by *pyr 3a* (37301), on the other hand, display normal aspartic transcarbamylase activity (1), and the pyrimidine requirement is entirely or almost entirely eliminated in the presence of *s* (2-4). Previous work indicates that the *pyr 3a* mutation affects a step in the synthesis of pyrimidines which lies prior

to the appearance of the product of the ATC reaction, ureidosuccinic acid (US) (1). Such steps may be the ATC reaction itself, or the availability of its substrates, carbamyl phosphate (CAP) or aspartic acid.

Direct attempts to identify the reaction affected in *pyr 3a* have been unrewarding. A study of the action of the suppressor, *s*, was undertaken, therefore, because it reverses the effect of the *pyr 3a* mutation. Very small concentrations of arginine (0.05 $\mu\text{g}/\text{ml}$ medium) have been shown to restore a pyrimidine requirement to the suppressed mutant (*pyr 3a-s*) (4), indicating an inhibition of pyrimidine synthesis by arginine. Because ornithine transcarbamylase (OTC), catalyzing the formation of citrulline from carbamyl phosphate and ornithine, could well regulate arginine production, the effect of the suppressor gene upon this enzyme was investigated.

Growth conditions have been described previously (1). Acetone powder extracts were assayed for ornithine transcarbamylase activity by measuring the appearance of citrulline colorimetrically (5) in the following reaction mixture: 20 μmole of ornithine, 20 μmole of carbamyl phosphate, 250 μmole of tris acetate buffer, pH 9.0, and an aliquot of the extract; total volume, 3.25 ml; final pH, 8.7.

It was found that, under the conditions of the experiments, extracts of wild type, *pyr 3a* and *pyr 3d* mycelia at similar stages of growth displayed an ornithine transcarbamylase activity of 15 to 20 μmole of citrulline per milligram of protein per hour, while similar extracts of *pyr 3a-s* displayed activities of 0.2 to 0.6 $\mu\text{mole}/\text{mg}$ per hour. Ascus analysis of a cross of *pyr 3a-s* to wild type showed that low OTC activity segregated regularly with suppressor action, and, where *s* was expected in otherwise wild type genomes, OTC activity was also low.

Strains carrying *s* (without *pyr 3a*) grew normally on minimal medium, despite the great reduction of OTC activity. Such strains were stimulated, if at all, by only 6 percent in linear growth rate when arginine was added to the medium, while all wild type strains were unaffected by the addition of arginine. This finding indicates that growth was limited only slightly by the lowered OTC activity, and that the inhibition of *pyr 3a-s* by arginine is a function of the *pyr 3a* mutation rather than of *s*. Most important, the data strongly suggest that the basis of the

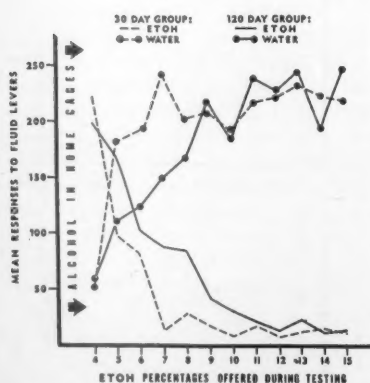


Fig. 2. Mean daily preferences for alcohol and water in rats whose fluid intakes in their home cages were restricted to 5-percent or 20-percent alcohol for 30 days and 120 days. These plots are based upon combined data of increasing-decreasing order groups and the 5- and 20-percent groups, and represent the mean fluid intakes on each 1-hour consecutive daily test session.

Table 1. Effect of arginine on the growth of *pyr 3a-s*. Minimal medium (25 ml) was inoculated with conidia of *pyr 3a-s*. Various amounts of arginine were added at the times indicated, and dry weights were measured subsequently.

Arginine Amount ($\mu\text{g}/\text{ml}$)	Time of medium (hr)	Dry weight (mg) at		
		37 hr	61 hr	85 hr
0.0		1.5	24.0	46.2
0.5	0	0.0	0.0	0.0
1.0	6			18.2
10.0	37	1.5	21.1	51.0
20.0	37	1.5	9.6	20.0
50.0	37	1.5	5.8	8.5
100.0	37	1.5	7.2	9.3

pyr 3a phenotype is a sensitivity of an early step in pyrimidine synthesis to endogenously produced arginine or arginine derivative. The suppressor, by reducing OTC activity, would presumably reduce the concentration of the inhibitory substance. This interpretation is further supported by the observation that certain arginine mutations also suppress *pyr 3a* when double mutants are grown in limiting arginine (3).

The postulated arginine sensitive step in pyrimidine synthesis in *pyr 3a* has not been identified. Experiments have shown that arginine has no apparent effect on the production or in vitro activity of aspartic transcarbamylase from this strain. That *pyr 3a* does not suffer a block in the utilization of pyrimidines is indicated by the findings that no pyrimidine precursors accumulate in limiting concentrations of supplement and that *pyr 3a* will grow on orotic acid (6).

The sensitivity of *pyr 3a-s* to arginine is most extreme in the conidial stage. While 0.5 μg of arginine per milliliter of medium completely inhibits the growth of conidial inocula for at least 7 days, much higher concentrations (20 $\mu\text{g}/\text{ml}$ or more) are required to delay growth if the same inocula are allowed to develop for 37 hours before arginine is added (Table 1). In other experiments, 50 to 100 μg of arginine per milliliter of medium were required to inhibit growth of media containing extremely limiting concentrations of uridine (5 to 10 $\mu\text{g}/\text{ml}$). The data indicate that growing mycelia, as opposed to conidia, may dispose of arginine by utilization or destruction, or both, rather quickly.

These findings may well be related to those of Fairley (7). His observations that a different *pyr 3* mutant (1298) will grow on α -amino butyrate or propionate, and that this growth is inhibited by arginine, suggest that the stimulatory compounds, like the sup-

pressor, may interfere with the synthesis (or the inhibitory action) of arginine, allowing the normal route of pyrimidine synthesis to operate. Alternatively, as he suggests, these compounds may be substrates of an alternate route of pyrimidine synthesis, also arginine sensitive. If the latter interpretation is correct, there is no obvious reason why the suppressed mutant, *pyr 3a-s*, could not synthesize pyrimidines by an alternate, unrecognized, and arginine-sensitive route. The data of Fairley, showing arginine inhibition on the "utilization" of the aliphatic acids in tests comparing conidial and mycelial inocula, are compatible with the similar inhibition of the suppressed mutant described here.

Enzyme assays of mixed extracts of *s* and *s⁺* mycelia have shown that the low OTC activity of *s* is not due to the production of an unbound inhibitor, the lack of a cofactor, or a competitive reaction. It is entirely possible that the *s* locus determines the primary structure of ornithine transcarbamylase; this hypothesis is reinforced by the finding that mutants at the *arg 2* and *arg 3* loci, partially blocked between ornithine and citrulline on nutritional criteria (8), both have normal or high OTC activities (9).

Other effects of the *s* mutation, notably its ability to suppress several proline-requiring mutants (3), and its ability to block the utilization of ornithine by ornithine-requiring mutants (3), are now more understandable in terms of a greatly reduced conversion of exogenous or endogenous ornithine to citrulline (10, 11).

Note added in proof. Subsequent experiments have shown that the *pyr 3* mutant 1298, used by Fairley for the study of growth on α -amino butyrate and propionate, closely resembles *pyr 3a* in the presence and specific activity of aspartic transcarbamylase under different nutritional conditions. This finding was made independently in Fairley's laboratory by Eugene Wampler. The finding suggests again the common basis of the action of the *s* gene and the effect of α -amino butyrate and propionate.

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24 April 1961

Arginine and Pyrimidine Biogenesis in *Neurospora*

Abstract. The growth-promoting activity of propionic acid and related compounds for the pyrimidine-less strain, *Neurospora crassa* 1298, is markedly inhibited by arginine. The data suggest that arginine exerts an inhibitory effect upon or represses the synthesis of an enzyme involved in pyrimidine formation.

There are numerous indications of a relation between the biosynthetic pathways leading on one hand to arginine and on the other to pyrimidine nucleotides (1). A new system for the examination of this relationship has been provided with the finding that several pyrimidine-less mutants of the mold, *Neurospora crassa*, are capable of growth in minimal medium supplemented only with propionate, α -aminobutyrate, or certain related substances (2, 3). The present report (4) is concerned with the discovery that arginine is a potent inhibitor of the growth-promoting effects of these compounds.

In the experiments described, the test organism was *N. crassa* 1298. Similar results were obtained with strain 37815, a strain which is pyrimidine-deficient only at temperatures above 32°C. The minimal medium and the methods used for the culture and the harvest of the mycelia have been described (2).

Results which typify the effect of arginine upon the growth of the mold in the presence of various growth-promoters are presented in Table 1. It may be noted that arginine in concentrations of 10 μg (about 0.006 μmole) per 25 ml of medium completely prevented growth in the presence of 50 μmole of either propionate or aminobutyrate. The molar ratio of arginine to these

Table 1. Effect of arginine on growth of *N. crassa* 1298. The values are averages of triplicate assays, each with 25 ml of minimal medium supplemented with either 4 μ mole of uridine or 50 μ mole of sodium propionate or aminobutyric acid. The growth periods were 3 days with uridine and 5 days with the other compounds.

L-arginine (mg/25 ml)	Dry mycelia (mg)
<i>Uridine (4 μmole)</i>	
0	45
10.0	47
<i>DL-α-amino-n-butyric acid (50 μmole)</i>	
0	25
0.001	20
.005	13
.010	0
<i>Sodium propionate (50 μmole)</i>	
0	17
0.001	8
.005	3
.010	0

growth-promoters necessary for 50 percent inhibition was of the order of 1:4000. On the other hand, arginine in concentrations as high as 10 mg/25 ml did not affect growth of the mutant in the presence of uridine. The arginine effect, therefore, must involve a relatively early stage of pyrimidine nucleotide formation.

The use of mycelial fragments for the inoculation process gave results similar to those described above for the usual conidial inoculum. When 1 mg of arginine was added to flasks which had been growing with propionate for 4 days (26 mg of mycelia), the growth in a subsequent 2-day period was only 10 mg of mycelia as compared with 16 mg for the controls. Also, experiments with mixtures of uridine and propionate or aminobutyrate demonstrated that the presence of 10 mg of arginine depressed growth to that obtained with the uridine alone. These results indicate that the arginine effect is not restricted to the germination process, although this may be the most susceptible stage. Higher concentrations of arginine are needed to inhibit growing mycelia, probably

Table 2. Comparison of the effect of various amino acids on growth of *N. crassa* 1298 in the presence of 50 μ mole of DL- α -amino-n-butyric acid per 25 ml of minimal medium. The incubation period was 5 days.

Supplementary compound	Concn. of supplement (μ mole/25 ml)	Wt. of dry mycelia (mg)
None		39
Arginine	0.03	11
Ornithine	0.6	17
Citrulline	6.0	30
Aspartic acid	37.0	22
Valine	43.0	12
Isoleucine	38.0	10

because the compound is removed rather rapidly by metabolic processes. With time, growth appears in inhibited cultures concomitantly with the disappearance of arginine from the medium.

Experiments with the other common aliphatic α -amino acids demonstrated that only ornithine, citrulline, aspartic acid, valine, and isoleucine had inhibitory effects in this system (Table 2), although all to a lesser degree than arginine. Ornithine was much more effective than citrulline, contrary to expectation if the action of these compounds required their conversion to arginine. This may reflect differences in membrane permeability or may indicate that ornithine affects growth in a manner different from arginine.

Attempts at this time to explain these effects must be regarded as speculation, for the primary metabolic defect in *N. crassa* 1298 is of unknown nature and the mechanisms by which propionate and aminobutyrate support growth remain to be elucidated. The available evidence suggests (5) that these compounds are pyrimidine precursors and that their use for pyrimidine synthesis involves adaptive mechanisms different from those of the common aspartate-otridylic acid pathway. It seems likely that any such utilization of these aliphatic acids requires the participation of coenzyme A at an early stage. The inhibitory action of valine and isoleucine may simply be the result of competition of their degradation products for this coenzyme.

Should the use of propionate for pyrimidine synthesis require a new transcarbamylase reaction, as is quite possible, then obvious opportunities would exist for aspartic acid and ornithine to inhibit the new transcarbamylase or to compete for the necessary carbamyl phosphate.

The mechanism of the striking inhibitory action of arginine also remains unknown. This amino acid certainly could be simply a powerful inhibitor of some enzyme. However, it may well be that the observed phenomenon is the result of the repression by arginine of the synthesis of an enzyme necessary for the utilization of propionate and aminobutyrate for pyrimidine formation. This mechanism may be of general importance in the metabolic control of pyrimidine biogenesis.

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24 April 1961

Antifungal Agent

Abstract. From the soil of the San Joaquin Valley a fungus has been isolated, an extract of which inhibits the growth of *Coccidioides immitis* on Sabouraud's medium. An acute toxicity study in mice indicates a certain tolerance of the extract. Tentative identification indicates that the fungus is a penicillium.

Early in 1958 certain attributes of a green fungus seen occasionally in the course of our soil survey study of *Coccidioides immitis* caused one of us (M.C.E.) to isolate it and study its effect upon other fungi. It was found to overgrow and displace *C. immitis* on modified Sabouraud's medium.

It was plated on 3-day-old cultures of *C. immitis* and 1 week later washings of this combined growth were injected intraperitoneally into 12 mice. At the same time equal amounts of a much lighter suspension of pure *C. immitis* were injected intraperitoneally into 12 other mice. All of the mice that received the pure *C. immitis* culture died of coccidioidomycosis within 3 months. Only three of the mice that received the combined suspensions died.

Further studies pointed to the need for making an extract of the fungus for determining its effect upon *C. immitis*. The 8-day-old cultures of fungus grown on modified Sabouraud's medium were heated in the autoclave at 250°F for 5 min, and the mat and substrate were extracted with chloroform. The chloroform was boiled off under distilled water, and when only a tarry residue remained at the bottom, the water with

Table 1. Results of acute toxicity study.

Mice (No.)	Amount of extract (ml)	Deaths (No.)
10	0.1	none
21	0.2	3
19	0.3	18
10	0.5	10

that part of the chloroform extract that it had taken up during the boiling was pipetted off. This distilled water extract was used for measuring the zone of inhibition of growth of *C. immitis* and for toxicity studies in mice.

One-tenth of a milliliter of this aqueous extract was placed on each of six testing disks and when dried these were placed in the center of 1-day-old cultures of two different strains of *C. immitis* growing on Sabouraud's medium. The average diameter of the zone of inhibition in the six cultures was 4.5 cm. The acute toxicity study performed in young mice averaging 21 g in weight gave the results shown in Table 1.

The extract has since been tried against *Microsporium gypseum* and a species of *Trichophyton* with moderate zones of inhibition; it is being tested against other fungi.

This green fungus has been tentatively identified by Chester Emmons at the National Institutes of Health as *Penicillium janthinellum* (1).

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Note

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6 April 1961

Significance of Some

Fossil Wood from California

In June 1952, N. L. Taliaferro, R. Taylor, and I found fragments of wood and gastropod shells in a sandstone boulder 600 feet above sea level in Angus Canyon, a tributary to Capay Valley, about 40 miles west-northwest of Sacramento, Calif. The wood was later identified (by L. H. Daugherty) as *Cupressinoxylon*, and the gastropods (by J. W. Durham) as *Cophocara*.

Although the boulder is firmly embedded in a conglomerate near the base of the Eocene Capay formation, it is dated as upper Cretaceous by its gastropods and by lithologic comparison with nearby upper Cretaceous sandstone exposures. Analyses were made on parts of the dark-brown wood fragment shown in Fig. 1.

The specific gravity, determined by immersing fine splinters of the wood in heavy liquids, ranges from about 2.3 to 2.7. X-ray analysis of a splinter (by Adolf Pabst) showed it to be chiefly calcite. Ignition of a small piece showed the ash content to be 51.6 percent by weight. This ash was unaffected by an Alnico magnet, suggesting that no magnetic iron was present, and hence that no pyrite was present in the original unburned sample (1). The ash, x-rayed by Pabst, was found to be calcium oxide with a trace of hydrated calcium oxide.

If, as the x-ray analysis suggested, the ash was wholly calcium oxide, calcined from calcite, one can easily calculate the weight percentage of calcite in the original—namely, 92.1 percent. This explains, in part, the high specific gravity of the wood.

A transverse thin section (Fig. 2) shows that the original vegetal structure is excellently preserved. Evidently the calcite permineralization occurred before decomposition had progressed far enough to weaken the cell walls. Indeed, in view of Goldberg and Parker's reconstruction of phosphatization of wood (2), it appears likely that calcification was synchronous with oxidation of the tissue.

With crossed nicols, both transverse and tangential thin sections show that the lumina are filled with calcite, but opaque cell walls make up almost half the apparent volume. In view of the high specific gravity, the cell walls, as well as the lumina, must be impregnated with calcite.

Transverse sections also show that much of the calcite is fine-granular, unlike that in the calcified wood described by Greenland and Wherry (3); individual grains are generally smaller than the lumina they fill, so that many cells contain more than one individual. C-axes of several of these, measured on a Universal stage, appear to be randomly oriented. The relatively fine granularity of the calcite suggests that crystallization began at closely spaced centers and proceeded rather uniformly and rapidly. This suggestion supports the inference that permineralization was synchronous with initial decomposition, presumably soon after deposition. Also supporting this idea is the fact that the wood, both micro- and macroscopically, appears to have been but little deformed and flattened by the weight of overlying sediments before calcification.

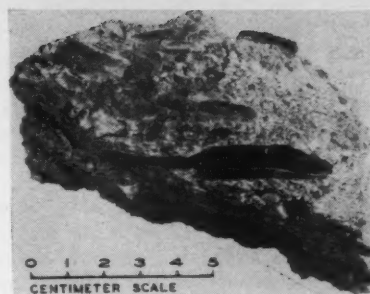


Fig. 1. Rock fragment showing piece of dark calcified *Cupressinoxylon* wood. Streaky gray fragments are other calcified wood chips; white fragments are shells of *Cophocara*, a gastropod with upper Cretaceous affinities.

The presence of *Cophocara* shells shows that the wood was deposited in a marine environment; coarse granularity of the sandstone suggests relatively strong local currents; absence of pyrite suggests relatively free circulation of the water. All of this points to an environment unlike that in which the wood of the Carboniferous coal balls was calcified—a restricted, anaerobic, lagoon or flood-plain environment.

The environment, though marine, was also different from that of the 410-m terrace, in the Gulf of Tehuantepec, from which Goldberg and Parker dredged phosphatized wood (2). They and others have suggested that, since the hydrogen-ion concentration requirements are similar for precipitation of calcium carbonate and calcium phosphate, the relative concentration of carbonate and phosphate ions in the water will determine whether calcite or apatite will be deposited.

Presumably, then, if the phosphate content of the Central Valley Cretaceous geosyncline was relatively low,



Fig. 2. Photomicrograph of transverse section of the wood fragment shown in Fig. 1. Crossed nicols. Width of view is approximately 0.45 mm.

calcite rather than apatite would have been deposited. The supposition that the phosphate content of the water was low is supported by the general paucity of Cretaceous fossil remains, especially of planktonic Foraminifera, in central California. A thriving marine animal community requires waters rich in phosphate. Such waters generally result from upwelling along open coasts. Hence, if the sea in the central California Cretaceous geosyncline was deficient in phosphate, as suggested by wood calcification and scarce marine fossils, it very likely was not receiving upwelled coastal marine waters. This line of reasoning tends to confirm the view of some geologists that the geosyncline was at least partially blocked off from the open sea during much of its existence.

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References and Notes

1. Ignition, under identical conditions, of black, Recent wood from another locality yielded ash that was strongly magnetic. The source of the magnetic iron is presumed to be pyrite in the original sample.
2. E. D. Goldberg and R. H. Parker, *Bull. Geol. Soc. Amer.* **71**, 631 (1960).
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17 April 1961

Benzpyrenes in Soil

Abstract. Benzpyrenes appear to be common and fairly abundant constituents of soils. Both the carcinogenic 3,4-benzpyrene and its inactive 1,2-isomer have been detected spectroscopically in extracts of soils from rural areas of the eastern United States.

Polynuclear aromatic hydrocarbons are commonly found in recent marine and nonmarine sediments (1, 2). Evidence has now been obtained that both the strongly carcinogenic hydrocarbon 3,4-benzpyrene and its inactive isomer 1,2-benzpyrene are common and fairly abundant constituents of solids.

Table 1. 3,4-Benzpyrene in soils.

Origin and type of soil	Conc. ($\mu\text{g}/\text{kg}$)
Oak forest, West Falmouth, Cape Cod, Mass.	40
Pine Forest, West Falmouth, Cape Cod, Mass.	40
Mixed forest, West Falmouth, Cape Cod, Mass.	1300
Mixed forest, eastern Connecticut	240
Garden soil, West Falmouth, Cape Cod, Mass.	90
Plowed field, eastern Connecticut	900

A number of soils from rural areas of Massachusetts and Connecticut were analyzed. After the samples were dried to constant weight at 110°C, 50 g of each soil sample were weighed and extracted in a Soxhlet by benzene-methanol (1:1). The solvent was then removed in a rotating evaporator, and the remaining extract was treated with warm iso-octane-benzene (3:2). The soluble fraction was again dried, taken up in boiling iso-octane, and immediately adsorbed on an 8-ml column of alumina (Brockman II). The elution was carried out with a graded series of iso-octane-benzene mixtures. In some cases, yellow nonhydrocarbon materials broke through in the hydrocarbon-fractions; they were then removed by rechromatography under identical conditions. The hydrocarbons in the eluates were detected by ultraviolet spectrophotometry (Cary model 14 spectrophotometer), with a Sawicki chart (3) and a punched-card file of hydrocarbon spectra as aids in their identification. The spectra of 3,4-benzpyrene and 1,12-benzperylene, which both occur in soils, are very similar, but the presence of fine structure in the 383- $m\mu$ band together with a high 403- $m\mu$ band constitute conclusive evidence for the presence of 3,4-benzpyrene (3).

The hydrocarbon assemblage in all soil samples was found to be very similar even if the concentrations varied. The 1,2- and 3,4- isomers of benzpyrene were detected in all samples. Figure 1 is the spectrum of a typical benzpyrene fraction, contaminated with some chrysene (responsible for the background absorption) and some perylene (peaks at 434 and 428 $m\mu$). The concentration of the biochemically active 3,4-benzpyrene was estimated from the intensity of the 403- $m\mu$ band (Table 1). In addition to the benzpyrenes, the following hydrocarbons were represented in all samples: phenanthrene, fluoranthene, pyrene, chrysene, perylene, and anthanthrene. Extensive rechromatography of the combined extracts provided evidence for the additional presence of anthracene, triphenylene, benzanthracene, benzfluorene, 1,12-benzperylene, and coronene.

Some soils may contain a much higher concentration of 3,4-benzpyrene than reported here. Kern (1), in his paper on the discovery of chrysene in some Swiss soils, describes the isolation of two additional hydrocarbons, not identified with certainty. The reported

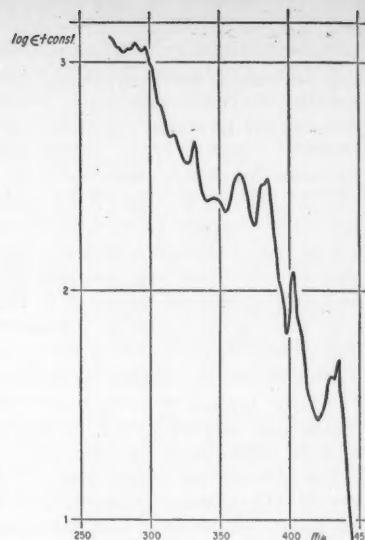


Fig. 1. Spectrum of a typical benzpyrene fraction, contaminated with some chrysene and some perylene (in iso-octane).

spectra and analytical data lead us to conclude that Kern already had isolated 3,4-benzpyrene [melting point: 171°C (benzpyrene: 177°C); molecular weight: 283 (benzpyrene: 252); $\log \epsilon_{1\%}^{1\text{cm}}$ (at 296 $m\mu$): 1.7×10^3 (benzpyrene: 2.2×10^3)]. According to Kern, this hydrocarbon was obtained in crystalline form with the remarkable yield of 21 mg/kg of soil.

We believe that the occurrence of such hydrocarbon concentrations in rural soils distant from major highways and industries cannot be ascribed to fallout from polluted air. More likely, these hydrocarbons are indigenous to soil. They are among the pyrolytic products of wood and might be formed in soil by related low-temperature processes, as they also occur in the transformation of plant organic matter to peat and lignite. Alternatively, the hydrocarbons might be the products of the organisms which contribute their organic matter to the soils. These genetic mechanisms—if correct—imply that man has been in contact with carcinogenic hydrocarbons, not only during the industrial epoch, but during his entire history. It remains to be examined whether the concentration and availability of the benzpyrene in soil is sufficient to be of concern to those exposed to continued contact with soil (4).

MAX BLUMER

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4. This investigation has been supported by a research contract, NONR 2196(00), with the Office of Naval Research. This report is contribution No. 1193 of the Woods Hole Oceanographic Institution.

4 May 1961

Hemorrhagic Disease in Rodents Infected with Virus Associated with Thai Hemorrhagic Fever

Abstract. KLA 16 virus, recovered from a child with Thailand hemorrhagic fever, produces infant mouse, rat, and hamster disease that is characterized by spontaneous bleeding at multiple sites, notably in the gastrointestinal tract, and by marked abnormalities in hemostatic mechanisms. This virus differs in this respect from Chikungunya virus to which it is immunologically similar and from other Thai hemorrhagic fever viruses.

Human virus infections, characterized by spontaneous hemorrhage, are recorded from widely separated areas of Asia, Europe, and South America. Immunologically distinct agents have been implicated in the etiology of these hemorrhagic fevers, but thus far only the viruses of Kyasanur Forest Disease and Omsk, Philippine, Argentine, and Thailand hemorrhagic fevers have been propagated in laboratory hosts (1, 2). These agents multiply in albino mice and produce fatal encephalitis with minimal apparent involvement of other major viscera. Recently a virus was recovered from the blood of a Thai child who contracted Thailand hemorrhagic fever in Bangkok in May 1960. This agent, KLA 16, was identified as an arthropod-borne virus of Casal's group A, closely related to Chikungunya virus and immunologically identical to TH 35 and BaH 306 viruses recovered from Thai patients by Hammon and Kitaoka, respectively (2, 3). KLA 16 virus differs from these, however, in its capacity to produce hemorrhagic disease in rodents. This report describes the hemorrhage-producing characteristics of KLA 16 virus and the factors thus far known to influence production of the hemorrhagic diathesis in experimental animals.

From the patient's blood obtained on the 2nd day of disease, virus was recovered simultaneously in mice 1 to 2 days old and in trypsinized explants of hamster kidney and rhesus kidney cells. These three isolates were transmissible interchangeably in each of the three

host systems and were immunologically identical. Intracerebral passage of infected brain or cell cultures resulted in subcutaneous and marked intraluminal intestinal hemorrhages in approximately 20 percent of inoculated mice. The bleeding tendency has been observed in mice inoculated with virus in as high as 12 mouse and 7 hamster kidney cell passages, with virus obtained after three terminal dilution passages in both suckling mice and hamster kidney cells.

Several factors influenced the occurrence of discernible hemorrhage after inoculation of mice (4). After infection with 10 to 100 intracerebral LD₅₀, several age-dependent patterns of disease were observed. Hemorrhage was seen only in mice infected before the 7th day of life. No hemorrhage, and only sporadic deaths were observed between 7 and 21 days of age, and older mice were resistant to lethal infection. The frequency and extent of hemorrhage was greatest in mice 24 to 48 hours old at inoculation. The intracerebral route of infection was more sensitive than subcutaneous or intraperitoneal inoculation for both the production of hemorrhagic disease and for quantitation of infectivity. Hemorrhage rarely followed subcutaneous or intraperitoneal inoculation of any amount of virus, and these routes were 1/100 as sensitive for detecting viable virus as intracerebral inoculation. By passing only virus from brains of hemorrhagic mice three times,

it was possible to increase the frequency of overt bleeding from 20 to 90 percent. Thus intracerebral inoculation of 10 to 100 LD₅₀ of this final virus seed into mice 24 to 48 hours old was found to be optimal for producing hemorrhagic disease.

Under these circumstances, normal activity of mice decreased about 72 hours after inoculation. All or portions of the small intestine were salmon pink in color, and when viewed under $\times 20$ magnification, marked dilatation and congestion of blood vessels in the wall was seen. Within a few hours, color changed from pink to gray, and as further hemorrhage occurred into the lumen, segments or large portions of the bowel turned black (Fig. 1). Black bowel contents were strongly benzidine- and guaiac-positive; blood in the intestine was always partially digested. Subcutaneous, intra-articular, and bladder wall hemorrhages occurred occasionally. Mice which showed hemorrhagic manifestations usually died within the next 24 hours. The moribund suckling mouse was characterized by congested jugular veins, enlarged heart, progressive cyanosis, and decrease in surface temperature, but no manifestation of disease in the central nervous system was seen. Histologic examination of the bowel failed to reveal specific sites of bleeding but confirmed the congestive changes and showed vacuolar degeneration of the cytoplasm of mucosal cells



Fig. 1. Hemorrhage into isolated loops of bowel of 5-day old mouse, 72 hours after infection with KLA 16 virus (right). Normal abdominal viscera (left).

in the area of bleeding. No other characteristic lesions were seen regularly in the major viscera of infected mice. Bone marrows had normal complements of megakaryocytes and myeloid and erythroid elements. Normal hematopoietic tissues were present in liver and spleen. The cellularity and architecture of the thymus was undisturbed (5).

The mechanism for hemorrhage is at present poorly understood, although certain defects in the hemostatic mechanism have been observed. Platelet counts in the normal mouse 4 to 5 days old ranged from 640,000 to 1,200,000/mm³ (average, 920,000/mm³). In hemorrhagic mice infected with KLA 16, platelets were decreased to a range of 60,000 to 450,000/mm³ (average, 220,000/mm³). However, mice of the same age infected and moribund with Chikungunya virus in the 169th mouse passage maintained platelet counts near the normal range, 550,000 to 950,000/mm³ (average, 700,000/mm³). No other cellular element of peripheral blood was depressed. Rather, hemorrhagic mice showed leukocytosis to 20,000/mm³ or more (normal 3000 to 5000/mm³), with the increase due primarily to polymorphonuclear cells (65 to 90 percent). Whether this polymorphonuclear response resulted directly from KLA 16 virus infection, or whether it was the result of bacterial invasion through a damaged gastrointestinal mucosa, is unknown. Mice infected with KLA 16 have had consistently prolonged bleeding times (approximately 5X) and capillary tube venous clotting times (approximately 3X) compared with normal controls and with Chikungunya infected mice. Pooled plasma samples from groups of five litter mates with gastrointestinal hemorrhage were moderately icteric and possessed prothrombin activity 30 to 40 percent of normal controls.

Both 2 to 3 day old Syrian hamsters and albino rats (Wistar) are susceptible to hemorrhagic manifestations of KLA 16 virus infection. Intestinal hemorrhages in suckling hamsters appeared to be less severe than those seen in mice, but subcutaneous and subungual hemorrhages were prominent. On the other hand, the hemorrhagic disease in suckling rats was similar, but somewhat more severe than that seen in mice. The adult hamster, rat, guinea pig, and rab-

bit are, like the adult mouse, refractory to overt infection.

Overt hemorrhagic phenomena have not been observed in animals infected with TH 35 virus, and were seen only rarely with BaH 306 virus infection, although platelet counts, bleeding, and clotting times in mice infected with both of these viruses were abnormal. The changes, however, were less pronounced than those induced by KLA 16 infection. Since TH 35 and BaH 306 viruses had been subjected to a number of consecutive mouse passages, their failure to induce hemorrhage may be due to their mode of adaptation to rodents, or differences in methods for initial recovery, or both.

Hemorrhagic fever in Thailand is an acute infection of children and is characterized by fever, petechial hemorrhage, purpura, gastrointestinal bleeding, and shock (2). Its clinical manifestations are thus similar to the experimental animal disease. Current knowledge of the etiology, pathogenesis, and the explanation for the hemorrhagic tendency of Thailand hemorrhagic fever is incomplete; however, recorded alterations of the human hemostatic mechanism are compatible with those observed in mice. The limitation of recognizable disease in Thailand to infants and children suggests that the severity of the human disease, like its rodent counterpart, may be dependent upon age. While the extent of similarities remains undetermined, the suckling animal offers a unique and valuable tool for investigation of the pathologic process of this disease and for assessing the roles played by host factors such as growth and physiologic development in its manifestations.

The explanations for differences in the hemorrhage-producing capacities of the three immunologically identical virus strains is similarly unknown. All strains of Thai hemorrhagic fever virus may possess this hemorrhagic property, a thesis which can be evaluated only by critical study of additional recovered viruses. In this respect the hemorrhagic tendency of these viruses may be an important marker for rapid recognition of virus in the field. Certainly the hemorrhage-inducing property is not directly associated with the known antigenic composition of the virus, since immunologically identical strains differ in

this capacity. The identification of this property with other marks of virus activity appears to be in order.

Finally, whether hemorrhage occurs in infected rodents may be dependent upon one or more interrelationships between virus and host. On one hand, source material might contain hemorrhage-producing variant in high concentration, or such a variant may propagate at rates favoring its selection. On the other, the characteristics of the host at the moment may be important in selecting different natural variants upon initial propagation, or in the recognition of hemorrhage-producing variants. Thus virus initially recovered in slightly older mice, or in other mouse strains, may have biologic characteristics different from the hemorrhage-producing variant (KLA 16) recovered in younger animals. The observed increase in the frequency of the hemorrhagic phenomenon after passage of virus from very young hemorrhagic mice tends to support the importance of host age and, further, implies that virus populations in nature are heterogeneous mixtures of hemorrhage- and nonhemorrhage-producing variants. These conditions may apply to other human hemorrhagic fever viruses. If this is so, further testing of the hypothesis should result in recovery of other hemorrhage-producing viruses in appropriate test animals.

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4. Mice used in these experiments were an inbred line of Bagg albinos, maintained in "pathogen-free" colonies at this Institute since 1956.
5. We are grateful to Harvey J. Weiss for hematologic assistance and suggestions, to William H. Crosby for hematologic review of histologic sections of experimental animals, and to John Batsakis for reviewing the histology of infected animal tissues.

29 May 1961

Meetings

Comparative Endocrinology

The 3rd International Symposium on Comparative Endocrinology was held at Oiso, Japan, 6-10 June 1961, under the sponsorship of the Zoological Society of Japan. The local planning committee, with K. Takewaki as chairman, included the other two professors of the Zoological Institute of the University of Tokyo, T. Fujii and H. Kinoshita; H. Kobayashi, who served as secretary; and N. Egami, who served as treasurer. The magnificent surroundings of Oiso on Sagami Bay, the excellent physical arrangements, and the generous hospitality of the Japanese hosts all helped to make this an unforgettable experience for participants from abroad.

There were 161 scientists attending the symposium, including 41 from the United States and 87 from Japan. Of the American delegates, 27 had received travel grants from the National Science Foundation and the National Institutes of Health. In addition to the American delegates there were 33 participants from Australia, Canada, France, East Germany, West Germany, Great Britain, Holland, Hong Kong, India, Italy, Sweden, Taiwan, Uganda, and the U.S.S.R.

The theme of the symposium was neuroendocrine and endocrine mechanisms in developmental, environmental, and metabolic adjustments. The International Committee attempted to avoid duplication of subject matter covered at the two previous symposia, at Liverpool and Cold Spring Harbor. The orientation was, in general, truly comparative. In addition, throughout the symposium there was special emphasis on recent advances in insect neuroendocrinology, to which Japanese biologists have contributed so notably. The proceedings of the symposium, including the discussion, are to be published as a supplement to *General and Comparative Endocrinology*.

The symposium was distinguished by

a successful effort to deal with topics of comparative endocrinology on a phenomenologic rather than a taxonomic basis. The line between vertebrates and invertebrates, so evident in much of the research in comparative physiology, was largely effaced by the inclusion of papers on a single topic in the same session, without regard to the taxonomic position of the animals discussed.

The session on hormone chemistry, with Ito (Tokyo) as chairman, covered insect hormones (Karlson, Munich) mammalian pituitary hormones (Li, Berkeley), and the immunology of pituitary and placental gonadotropins (Segal, Laurence, and Perlbachs, New York; Johnson, Iowa City). The session on hormones affecting environmental adjustment, with Gorbman (New York) as chairman, was concerned largely with fish endocrinology: water and electrolyte metabolism (Chester Jones and Phillips, Sheffield), iodine metabolism (Hickman, Edmonton), and the nature of thyrotropin (Fontaine and Fontaine, Paris). In addition, Ghosh (Calcutta) presented a paper on the avian adrenal.

Pigmentary phenomena, in a session with Li as chairman, were considered in crustaceans (Fingerman and Aoto, New Orleans and Sapporo), insects (Joly, Strasbourg), amphibians (van Oordt and Burgers, Utrecht), and mammals including man (Shizume, Mori, and Lerner, Tokyo and New Haven). Shizume's presentation emphasized the mode of action of intermedin and other pigment-influencing factors and led to a rewarding discussion. A session on neuroendocrine phenomena, with Welsh (Cambridge, Mass.) as chairman, included a general consideration of neurosecretory cells (Bern, Berkeley) and three papers on hypothalamo-hypophyseal relations: two on amphibians (Voitkevich, Voronezh; Etkin, New York) and one on birds (Farner, Wolfson

and Kobayashi, Pullman, Evanston, and Tokyo). Hormonal regulation on behavioral phenomena was considered, in a session with Benoit (Paris) as chairman, in insects (Hodgson, New York) and in fish (Baggerman, Groningen; Hoar, Vancouver). Marshall (Clayton) commented on the problem of physiologic races in birds.

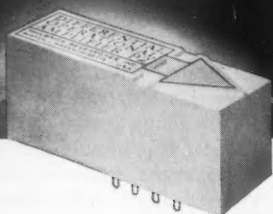
Two sessions, with Gallien (Paris) and van Oordt (Utrecht) as chairmen, were devoted to integration of reproductive functions in a variety of animal groups. The annelids were surveyed by Dürchön (Lille) and the crustaceans, with special emphasis on the androgenic gland, by Charniaux-Cotton (Gif-sur-Yvette). Reproductive phenomena in elasmobranchs (Chieffi, Naples), teleosts (Egami and Ishii, Tokyo; Ramaswami, Jodhpur), amphibians (Ramaswami), birds (Benoit), and mammals (Takewaki, Tokyo) were all considered. Mitskevich (Moscow) contributed a paper on the hormonal relationship between mother and fetus in mammals.

Hormones in relation to development were covered in the final two sessions, with Mitskevich and Bern as chairmen. Extensive attention was paid to the important work being done on insect metamorphosis and related phenomena, by Wigglesworth (Cambridge, England), Gersch (Jena), Williams (Cambridge, Mass.), Ichikawa (Kyoto), and Fukuda (Matsumoto). Gene-hormone interaction in sexual differentiation was discussed in fish by Yamamoto (Nagoya) and in amphibians by Gallien. A paper by Witschi and Dale (Iowa City) on steroid hormones in early vertebrate development concluded the symposium.

There were excellent opportunities for scientific and social exchange at the symposium. A panel, organized and headed by Emil Witschi, devoted an afternoon to considering "perspectives in endocrinology." Panelists included the scientific attaché of the U.S. Embassy in Tokyo, W. R. Boss; R. T. Hill from the National Institutes of Health, Bethesda; R. K. Meyer (Madison); T. Uchida (Sapporo), president of the Zoological Society of Japan; and Benoit, Chester Jones, Karlson, Mitskevich, Wigglesworth, and Williams.

No symposium could cover the subject matter in question without some appreciable gaps. In the present instance, despite the breadth of coverage, one could wish there had been papers on the important recent work on the

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molecular and functional evolution of neurohypophyseal principles associated with the names of W. H. Sawyer, H. Heller, and J. Maetz; on higher nervous centers as they impinge upon the hypothalamo-hypophyseal complex; and on the insect subesophageal ganglion as an endocrine structure. Crustacean neuroendocrinology, too, was only touched upon.

The 4th International Symposium will be held in Paris in 1964, under the leadership of Louis Gallien. It will face the challenge of maintaining the high quality of the first three symposia and of providing continued coverage of "frontier" areas in the growing field of comparative endocrinology.

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Forthcoming Events

September

1-5. Danube Research, intern. symp., Budapest, Hungary. (Biological Sciences Group, Hungarian Acad. of Sciences, Roosevelt Tèr. 9, Budapest V)

1-9. Topology and Its Methods in Other Mathematical Disciplines, symp., Prague, Czechoslovakia. (Organizing Committee, Ke Karlovu 3, Prague 2)

1-10. International Pharmaceutical Students' Federation, 7th congr., Munich, Germany. (U. Peto, 10 Groffstr., Munich 19)

2-7. International Assoc. for Quaternary Research, Warsaw, Poland. (R. Galon, Secretary General, INQUA, Geographical Inst. Univ., Torun, Poland)

2-9. International Soc. of Surgery, 19th congr., Dublin, Ireland. (T. C. J. O'Connell, 35 Fitzwilliam Pl., Dublin)

3-7. International Assoc. for Hydraulic Research, 9th congr., Belgrade, Yugoslavia. (H. J. Schoemaker, Waterloopkundig Laboratorium, Raam 61, Delft, Netherlands)

3-8. American Chemical Soc., 140th meeting, Chicago, Ill. (A. T. Windstead, National Meetings Dept., ACS, 1155 16 St., NW, Washington 6)

3-9. International Federation of Gynaecology and Obstetrics, 3rd world congr., Vienna, Austria. (V. Grünberger, Medizinische Akademie, Alserstrasse 4, Vienna 9)

3-10. Inter-American Congr. of Radiology, 7th, São Paulo, Brazil. (W. Bomfim-Pontes, Rua Cesario Motta 112, São Paulo)

4. World Federation for Mental Health, 14th annual, Paris, France. (WFMH, 19 Manchester St., London, W.1, England)

4-6. International Assoc. for Shell Structures, colloquium, Brussels, Belgium. (Prof. Dutron, 127 Avenue Adolphe Buyl, Brussels 5)

4-6. International Symp. on the Earth Storm, Kyoto, Japan. (T. Nagata, Science Council of Japan, Ueno Park, Tokyo)

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SCIENCE, VOL. 134

4-7. Neuropathology, 4th intern. congr., Munich, Germany. (W. Haymaker, Armed Forces Inst. of Pathology, Walter Reed Army Medical Center, Washington 25)

4-7. Rheumatology, 10th intern. congr., Rome, Italy. (C. B. Ballabio, Clinica Medica Generale, Via F. Sforza 35, Milan, Italy)

4-8. Low Energy Nuclear Physics, intern. conf., Manchester, England. (L. J. B. Goldfarb, Physics Dept., Univ. of Manchester, Manchester)

4-8. Pharmaceutical Sciences, 21st intern. congr., Pisa, Italy. (Intern. Pharmaceutical Federation, 11 Alexanderstraat, The Hague, Netherlands)

4-8. Plasma Physics and Controlled Nuclear Fusion Research, conf., Salzburg, Austria. (Intern. Atomic Energy Agency, United Nations, New York, N.Y.)

4-9. International Assoc. for Analog Computation, 3rd intern. sessions, Belgrade, Yugoslavia. (D. Strujic, Decanska 14/IV, Belgrade)

4-9. International Congr. of Angiology, 4th, Prague, Czechoslovakia. (Z. Reinis, 4th Medical Clinic, Prague 2/499)

4-9. International Symp. on Fundamental Problems in Turbulence and Their Relation to Geophysics (by invitation), Marseilles, France. (Intern. Union of Geodesy and Geophysics, 53 Avenue de Breteuil, Paris 7)

4-9. Laurentian Hormone Conf., Hoberg's Resort, Lake County, Calif. (Committee on Arrangement of the Laurentian Hormone Conference, 222 Maple Ave., Shrewsbury, Mass.)

4-13. Inter-African Conf. for Food and Nutrition, 4th, Bukavu, Congo Republic. (Commission for Technical Cooperation in Africa South of the Sahara, Pvt. Mail Bag 2359, Lagos, Nigeria)

4-14. Anglo-American Aeronautical Conf., 8th, London, England. (Inst. of Aerospace Sciences, 2 E. 64 St., New York, N.Y.)

5-8. International Congr. of Homeopathic Medicine, 25th, Amsterdam, Netherlands. (J. L. Fontein, Westzijde 116, Zaandam, Netherlands)

5-8. Machine Translation of Languages and Applied Language Analysis, intern. conf., Teddington, England. (L. Dostert, Director, Machine Translation Research, Georgetown Univ., 1715 Massachusetts Ave., NW, Washington 6)

5-8. National Chemical Exposition, 11th, Chicago, Ill. (Chicago Section, American Chemical Soc., 86 E. Randolph St., Chicago 1)

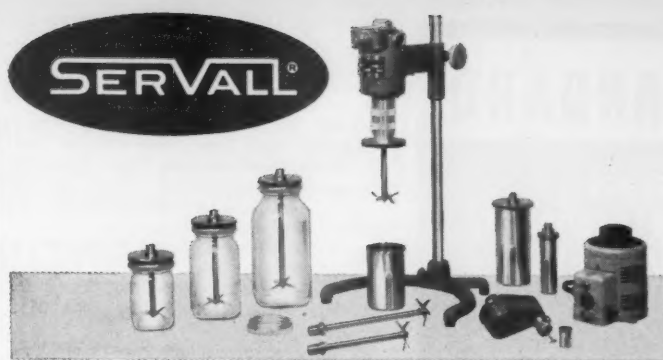
6-8. Effects of Ionizing Radiations on Immune Processes, intern. symp., Lawrence, Kan. (C. A. Leone, Dept. of Zoology, Univ. of Kansas, Lawrence)

6-8. Transmission and Processing of Information, intern. symp., Boston, Mass. (R. M. Fano, Research Laboratory of Electronics, Massachusetts Inst. of Technology, Cambridge 39)

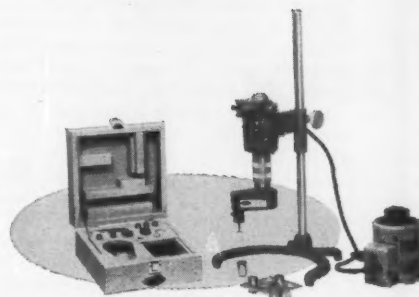
6-12. Human Genetics, 2nd intern. conf., Rome, Italy. (L. Gedda, 5 Piazza Galeno, Rome)

7-8. Pacific Slope Biochemical Conf., annual, San Diego, Calif. (R. G. Wolfe, Chemistry Dept., Univ. of Oregon, Eugene)

7-9. International Cardiovascular Soc.,



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5th congr., Dublin, Ireland. (H. Haimovici,
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7-9. Parapsychological Assoc., 4th an-
nual congr., New York, N.Y. (C. B. Nash,
St. Joseph's College, Philadelphia, Pa.)

7-10. Science News Writing Seminar,
Colorado State Univ., Fort Collins. (M.
G. Payne, Colorado State Univ., Research
Foundation, Fort Collins)

7-11. European Orthodontic Soc., 37th
congr., Bologna, Italy. (N. Gray, 16 Col-
lege Rd., Eastbourne, Sussex, England)

7-12. Neurogenetics, symp., Rome,
Italy. (L. Gedda, Instituto Gregorio
Mendel, Viale Regina Margherita 261,
Rome)

7-13. Electroencephalography and Clini-
cal Neurophysiology, 5th intern. congr.,
Rome, Italy. (R. Vizioli, Viale Università
30, Rome)

10-14. Tuberculosis Conf., 16th intern.,
Toronto, Canada. (C. W. L. Jeanes, 265
Elgin St., Ottawa, Ont., Canada)

10-15. Neurology, 7th intern. congr.,
Rome, Italy. (G. Alema, Viale Università
30, Rome)

10-17. International Union of Forest
Research Organizations, 13th congr.,
Vienna, Austria. (Forest Research Inst.,
IUFRO Bureau, Vienna 89)

11-13. European Organization for
Quality Control, 5th congr., Turin, Italy.
(Weena 700, Rotterdam, Netherlands)

11-14. International Flax and Hemp
Federation, 12th congr., Lisbon, Portugal.
(IFHF, 37 rue de Courcelles, Paris 8)

11-15. Cosmic Rays, 7th intern. conf.,
Kyoto, Japan. (Y. Sekido, Science Coun-
cil of Japan, Ueno Park, Tokyo)

11-15. Cybernetics, 3rd intern. congr.,
Namur, Belgium. (Intern. Assoc. for
Cybernetics, 13 rue Basse-Marcelle,
Namur)

11-15. Instrument Soc. of America,
instrument-automation conf. and exhibit,
16th, Los Angeles, Calif. (W. H. Kush-
nick, 313 Sixth Ave., Pittsburgh 22, Pa.)

11-15. Marine Sciences Instrumentation,
symp., Woods Hole, Mass. (D. D. Ket-
chum, Woods Hole Oceanographic Insti-
tution, Woods Hole, Mass.)

11-15. Radioecology, symp., Fort Col-
lins, Colo. (Miss A. Barker, American
Inst. of Biological Sciences, 2000 P St.,
NW, Washington 6)

11-16. International Union for the
Scientific Study of Population, 12th
congr., New York, N.Y. (C. V. Kiser,
Milbank Memorial Fund, 20 Wall St.,
New York 5)

11-16. University of Hong Kong,
intern. scientific congr., Hong Kong.
(University of Hong Kong, Hong Kong)

11-19. International Congr. of Naviga-
tion, 20th, Baltimore, Md. (E. W. Adams,
Jr., 22 Light St., Baltimore 2)

11-21. International Cloud Physics
Conf., Canberra and Sydney, Australia.
(E. G. Bowen, Commonwealth Scientific
and Industrial Research Organization,
University Grounds, Sydney)

12-13. International Federation of Sur-
gical Colleges and Societies, 4th annual
Oslo, Norway. (K. Cassels, IFSC Office,
Royal College of Surgeons of England,
Lincoln's Inn Fields, London, W.C.2)

12-15. International Pharmaceutical
Federation, 19th general assembly, Athens,

Greece. (J. H. M. Winters, Alexander-
straat 11, The Hague, Netherlands)

12-15. Mass Spectrometry, conf., Ox-
ford, England. (W. J. Brown, Instrumenta-
tion Div., A.E.I. (Manchester) Ltd., Traf-
ford Park, Manchester 17, England)

15-20. World Medical Assoc., 15th gen-
eral assembly, Rio de Janeiro, Brazil.
(L. H. Bauer, 10 Columbus Circle, New
York 19)

13-16. European Congr., of Gerontol-
ogy, 3rd, Amsterdam, Netherlands. (A. J.
S. Douma, Haanplein 8, The Hague,
Netherlands)

14-17. Chemotherapy, 2nd intern.
symp., Naples, Italy. (P. Preziosi, Casella
postale 266, Naples)

14-20. High Energy Physics, intern.,
Aix-en-Provence, France. (E. W. D. Steel,
European Organization for Nuclear Re-
search, Geneva 23, Switzerland)

16-20. German Soc. for the History of
Medicine, Physical Science and Technol-
ogy, Augsburg, Germany. (G. Mann, Sec-
retary, Wilhelmplatz 7, Bonn, Germany)

16-27. International Scientific Film
Assoc., 15th congr., Rabat, Morocco. (M.
Afifi, 85 Ibn Toumert, Rabat)

18-2. World Meteorological Organiza-
tion, Commission for Aerology, 3rd ses-
sion, Rome, Italy. (WMO, 1 Avenue de la
Paix, Geneva, Switzerland)

18-20. Applied Spectroscopy, 8th symp.,
Ottawa, Canada. (R. Lauzon, Div. of Pure
Chemistry, National Research Council,
Ottawa, Ont.)

18-21. Embryological Conf., 5th intern.,
London, England. (L. Brent, Dept. of Zo-
ology, University College, London, Grover
St., London, W.C.1)

18-22. International Congr. of Neuro-
radiology, 6th Rome, Italy. (E. Valentino,
CIT, Ufficio Congressi, Piazza Colonna
193, Rome)

18-23. Speleology, 3rd intern. congr.,
Vienna, Austria. (Generalsekretariat des
3rd Internationalen Kongresses für
Speläologie, Obere Donaustr. 99/7/1/3,
Vienna 2)

18-25. International Seaweed Symp.,
4th, Biarritz, France. (M. Barriety, Centre
Scientifique, B. P. 28, Biarritz.)

19-21. International Mechanical Pul-
ping Conf., 4th, Chicago, Ill. (J. H. Perry,
Norton Co., Worcester, Mass.)

19-29. International Conf. on Fish
Nutrition, Washington, D.C. (FAO, Intern.
Agency Liaison Branch, Office of the Di-
rector General, Viale delle Terme di
Caracalla, Rome, Italy)

19-22. Australian Conf. on Food Tech-
nology, Homebush (near Sydney), Aus-
tralia. (T. B. Partridge, Australian Scien-
tific Liaison Office, 1907 K St., NW, Wash-
ington 6)

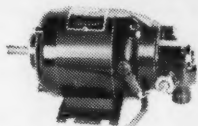
19-22. International Office of Docu-
mentation of Military Medicine, 23rd ses-
sion, Athens, Greece. (Intern. Committee
of Military Medicine and Pharmacy, Hô-
pital Militaire, 79 rue Saint Laurent,
Liège, Belgium)

20-21. Industrial Electronics, symp.,
Boston, Mass. (W. M. Trenholme, General
Electric Co., West Lynn, Mass.)

21-22. Conference on Radiofrequency
Spectroscopy in Solids, Bangor, Wales.
(Physical Soc., 1 Lowther Gardens, Prince
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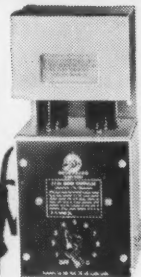


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21-23. French Medical Congr., 33rd, Paris. (C. Laroche, 34 rue de Bassano, Paris 8)

24-27. American Inst. of Chemical Engineers, Lake Placid, N.Y. (E. R. Smoley, 30 School Lane, Scarsdale, N.Y.)

25-29. European Committee of Liaison for Cellulose and Paper, symp., Oxford, England. (British Paper and Board Makers' Assoc., Technical Section, St. Winifred's, Welcomes Rd., Kenley, Surrey, England)

25-30. Magnetism and Crystallography, intern. conf., Kyoto, Japan. (Science Council of Japan, Ueno Park, Tokyo)

26-30. European Congr. of Aviation Medicine, 6th, Paris, France. (CERMA, 5 bis Avenue de la Porte de Sèvres, Paris 15)

27-3. International Union of Theoretical and Applied Mechanics, Kiev, U.S.S.R.

(Y. A. Mitropolsky, Scientific Committee, Kalinin pl. 6, Mathematical Inst., Kiev)

28-29. European Conf. of Chemical Engineers, Toulouse, France. (Soc. of Industrial Chemistry, 28 rue Saint-Dominique, Paris 7, France)

October

1-3. Council for Intern. Organizations of Medical Sciences, Paris, France. (CIOMS, 6 rue Franklin, Paris 16)

1-4. Process Engineers, annual, Vienna, Austria. (Osterreichischer Ingenieur- und Architektenverein, Eschenbachgasse 9, Vienna 1)

1-5. Electrochemical Soc., Detroit, Mich. (Electrochemical Soc., Inc., 1860 Broadway, New York 23)

1-7. International Special Committee on

Radio Interference, plenary session, Philadelphia, Pa. (S. D. Hoffman, American Standards Assoc., 10 E. 40 St., New York 16)

1-8. International Congr. of Industrial Chemistry, 33rd, Bordeaux, France. (Société de Chimie Industrielle, 28 rue Saint-Dominique, Paris 7, France)

2-4. Communications Symp., 7th natl., Utica, N.Y. (R. K. Walker, 34 Bolton Rd., New Hartford, N.Y.)

2-7. International Astronautical Federation, 12th congr., Washington, D.C. (American Rocket Soc., 500 Fifth Ave., New York 36)

2-7. Inter-Regional Leprosy Conf., Istanbul, Turkey. (WHO, Regional Office for Europe and Regional Office for the Eastern Mediterranean, 8 Scherfigsvej, Copenhagen Ø, Denmark)

2-7. Climatic Change, symp., Rome, Italy. (UNESCO, Place de Fontenoy, Paris 7, France)

2-11. International Council for the Exploration of the Sea, 49th annual, Copenhagen, Denmark. (Charlottenlund Slot, Charlottenlund, Denmark)

3-5. Physics and Nondestructive Testing, symp., Argonne, Ill. (W. J. McGonagle, Argonne Natl. Laboratory, 9700 S. Cass Ave., Argonne)

3-8. Aerosol Congr., 3rd intern., Lucerne, Switzerland. (Federation of European Aerosol Assocs., Waisenhausstrasse 2, Zurich, Switzerland)

4-10. Latin American Congr. of Electroencephalography, 5th, Mexico, D.F. (J. Hernandez Paniche, Instituto Mexicano de Seguro Social, Hospital La Raza, Mexico, D.F.)

4-10. Latin American Congr. of Neurosurgery, 9th, Mexico, D.F. (J. H. Mateos, Tonalá No. 15, Mexico 7, D.F.)

6-7. American Medical Writers' Assoc., New York, N.Y. (S. O. Waife, P.O. Box 1796, Indianapolis 6, Ind.)

6-8. Therapeutics, 7th intern. congr., Geneva, Switzerland. (P. Rentchnick, Case Postale 229, Geneva 2)

8-10. Zooplankton Production, symp., Copenhagen, Denmark. (J. H. Frazer, Marine Laboratory, P.O. Box 101, Victoria Rd., Aberdeen, Scotland)

8-11. Society of American Foresters, Minneapolis, Minn. (H. Clepper, SAF, 425 Mills Bldg., Washington 6)

8-13. American Acad. of Ophthalmology and Otolaryngology, Chicago, Ill. (W. L. Benedict, 15 Second St., SW, Rochester, Minn.)

9-11. National Electronics Conference and Exhibition, 17th annual, Chicago, Ill. (NEC, 228 N. La Salle St., Chicago, 1)

9-12. Instrument Symp. and Research Equipment Exhibit, 11th annual, Bethesda, Md. (J. B. Davis, Natl. Institutes of Health, Bethesda 14)

9-12. Water Pollution Control Federation, 34th annual, Milwaukee, Wis. (R. E. Fuhrman, 4435 Wisconsin Ave., NW, Washington 16)

9-13. American Rocket Soc., space flight meeting, New York, N.Y. (ARS, 500 Fifth Ave., New York 36)

9-13. Luminescence of Inorganic and Organic Systems, intern. conf., New York, N.Y. (Miss G. M. Spruch, New York Univ., Washington Sq., New York 3)

10-12. Nuclear Reactor Chemistry, 2nd

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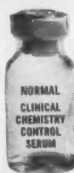
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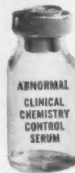
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Uric Acid



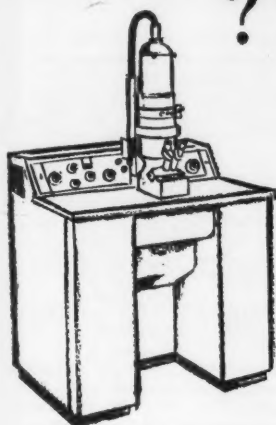
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Protein-bound Iodine
Sodium
Transaminase (SGO-T)
Urea Nitrogen
Uric Acid

*Component represents actual enzyme activity

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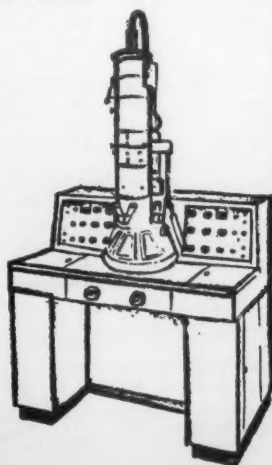
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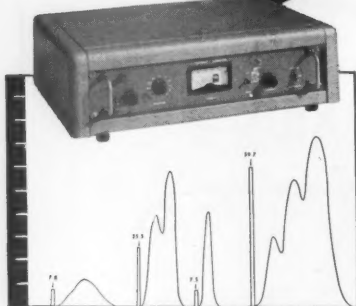
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conf., and Analytical Chemistry in Nuclear Reactor Technology, 5th conf., Gatlinburg, Tenn. (Oak Ridge Natl. Laboratory, P.O. Box X, Oak Ridge, Tenn.)

10-20. International Committee for Biological Control, Tunis. (P. Grison, Laboratoire de Biocénologie et de Lutte Biologique, La Minière, par Versailles (S.-et.-O.), France)

11-13. Gaseous Electronics Conf., American Physical Soc., Schenectady, N.Y. (C. J. Gallagher, General Electric Research Laboratories, Schenectady, N.Y.)

11-14. Tau Beta Pi Assoc., Cincinnati, Ohio. (R. H. Nagel, Univ. of Tennessee, Knoxville)

11-14. Western Inst. on Epilepsy, 13th annual conf., San Antonio, Tex. (F. Risch, 3097 Manning Ave., Los Angeles, Calif.)

12-13. Congress of Neurological Surgeons, New York, N.Y. (E. Weiford, 4706 Broadway, Kansas City 12, Mo.)

12-29. Pacific Intern. Trade Fair, 2nd, technical meetings, Lima, Peru. (PITF, P.O. Box 4900, Lima)

14-20. International Congr. of Neurological Surgery, 2nd, Washington, D.C. (B. S. Ray, 525 E. 68 St., New York 21)

15. American College of Dentists, Philadelphia, Pa. (O. W. Brandhorst, 4236 Lindell Blvd., St. Louis, Mo.)

15-20. American Inst. of Electrical Engineers, fall general meeting, Detroit, Mich. (E. C. Day, AIEE, 33 W. 39 St., New York 18)

15-20. International Congr. of Allergology, 4th, New York, N.Y. (W. B. Sherman, 60 E. 58 St., New York 22)

15-21. Pan American Congr. of Endocrinology, 5th, Lima, Peru. (M. San Martin, Av. Central 325, San Isidoro, Lima)

16-17. Engineering Writing and Speech, natl. symp., East Lansing, Mich. (J. D. Chapline, Philco Corp., 3900 Welsh Rd., Willow Grove, Pa.)

16-17. Ionization of the Air, intern. conf., Philadelphia, Pa. (I. C. Kornbluh, American Inst. of Medical Climatology, 1618 Allengrove St., Philadelphia 24)

16-18. American Soc., of Safety Engineers, Chicago, Ill. (A. C. Blackman, 5 N. Wabash Ave., Chicago 2)

16-18. Entomological Soc. of Canada and Entomological Soc. of Quebec, Quebec, Canada. (L. L. Reed, ESC, Neathy Bldg., Carling Ave., Ottawa, Canada)

16-18. Metallurgy of Beryllium, intern. conf., London, England. (Secretary, Inst. of Metals, 17 Belgrave Sq., London, S.W.1)

16-19. American Dental Assoc., Philadelphia, Pa. (H. Hillenbrand, 222 E. Superior St., Chicago 11, Ill.)

16-19. Vacuum Science and Technology, 2nd intern. congr., Washington, D.C. (W. M. Welch, Intern. Organization for Vacuum Science and Technology, 1515 Sedgwick St., Chicago 10, Ill.)

16-20. American Ornithologists' Union, Washington, D.C. (H. G. Deignan, U.S. National Museum, Washington 25)

16-20. American Soc. of Civil Engineers, New York, N.Y. (W. H. Wisely, 33 W. 39 St., New York 18)

16-20. Symposium on the Programming and Utilization of Research Reactors, Vienna, Austria. (Intern. Atomic Energy Agency, Room 2249, United Nations, New York, N.Y.)

17-19. Japan Conf. of Radioisotopes, 4th, Tokyo. (R. Suga, Japan Atomic Industrial Forum, Inc., No. 1, 1-Chome, Shiba Tamura-cho, Minato-ku, Tokyo)

18-20. Design of Experiments in Army Research, Development, and Testing, 7th conf. (by invitation only), Fort Monmouth, N.J. (F. G. Dressel, Army Research Office (Durham), Box CM, Duke Station, Durham, N.C.)

18-20. Optical Soc. of America, Los Angeles, Calif. (Miss M. E. Warga, 1155 16 St., NW, Washington 6)

19-20. International Geophysics Assoc., 12th colloquium, Salzburg, Austria. (IGA, Freisaalgasse 31, Salzburg)

19-21. Indiana Acad. of Science, Terre Haute. (E. D. Weinberg, Dept. of Bacteriology, Indiana Univ., Bloomington)

20-21. Shallow Water Research Conf., Atlantic Coast, 1st natl., Baltimore, Md. (D. S. Gorsline, Oceanographic Inst., Florida State Univ., Tallahassee)

20-24. American Heart Assoc., annual, Miami Beach, Fla. (AHA, 44 E. 23 St., New York 10)

23-25. International Scientific Radio Union and Inst. of Radio Engineers, fall meeting, Austin, Tex. (Miss H. E. Hart, U.S.A. Natl. Committee URSI, 2101 Constitution Ave., NW, Washington 25)

23-25. Metallurgical Soc. of the American Inst. of Mining, Metallurgical and Petroleum Engineers, fall meeting, Detroit, Mich. (AIME, 29 W. 39 St., New York 18)

23-27. Metal Congr. and Exposition, 43rd natl., Detroit, Mich. (A. R. Putnam, American Soc. for Metals, Metals Park, Novelty, Ohio)

23-28. Congress of Chemical Engineering, 1st, San Juan, P.R. (R. Munoz, Apartado 47, Estación de Río Piedras, San Juan)

24-25. Shallow Water Research Conf., Gulf Coast, 1st natl., Tallahassee, Fla. (D. S. Gorsline, Oceanographic Inst., Florida State Univ., Tallahassee)

24-26. Aerospace Nuclear Propulsion, intern. symp., Las Vegas, Nev. (P. M. Uthe, Lawrence Radiation Laboratory, Univ. of California, Box 808, Livermore)

24-27. American Dietetic Assoc., 44th annual, St. Louis, Mo. (Mrs. T. Pollen, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

26-27. American Soc. of Tool and Manufacturing Engineers, Toronto, Canada. (A. Cervenka, Vanderbilt Blvd., Oakdale, L.I., N.Y.)

26-27. Instrumentation Facilities for Biomedical Research, symp., Omaha, Neb. (H. G. Beenken, Univ. of Nebraska College of Medicine, 42 and Dewey Ave., Omaha)

26-27. New Mexico Acad. of Science, Albuquerque. (K. G. Melgaard, P.O. Box 546, Mesilla Park N.M.)

26-28. Professional Group on Electron Devices, annual meeting, Washington, D.C. (I. M. Ross, Technical Program Chairman, Room 2A-329, Bell Telephone Laboratories, Murray Hill, N.J.)

26-30. American Soc. for Aesthetics, Detroit, Mich. (J. R. Johnson, Cleveland Museum of Art, Cleveland 6, Ohio)

27-28. Shallow Water Research Conf., Pacific Coast, 1st natl., Los Angeles, Calif. (D. S. Gorsline, Oceanographic Inst., Florida State Univ., Tallahassee)



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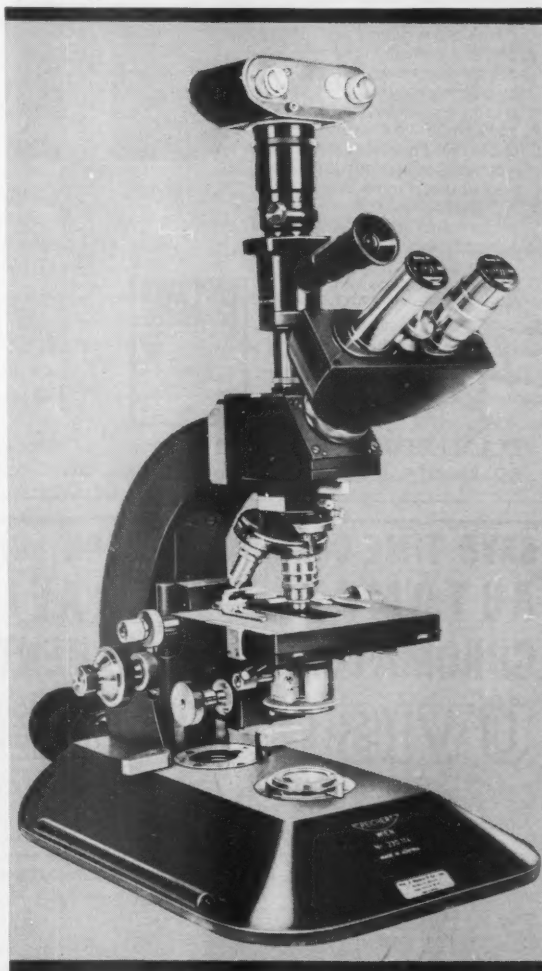


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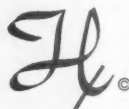
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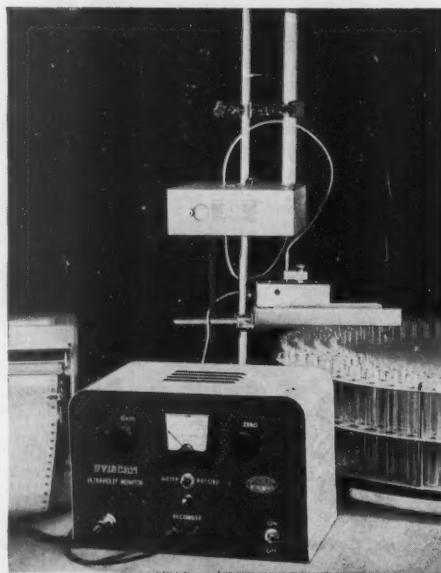
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Digital voltmeter measures from 100 μ v to 1.500 kv in five ranges. Display is by means of optical projection and is free from ambiguity; red and black backgrounds signify positive and negative inputs, respectively. Input impedance is 10 megohms except on the lower two ranges which have impedances of 1 and 0.1 megohm. Long-term accuracy is said to be ± 0.1 percent of full scale in each range. Two additional voltage ranges of 100 and 1000 v have input impedances of 100 megohms and accuracy ± 0.5 percent. Readout time is constant at 280 msec. Normally voltage is measured continuously. An adjustable dead zone permits jitter free readings in the presence of transients. Short or long time constant is selectable. The internal Zener reference can be preset to its precise value and corrected if necessary against a built-in Weston standard cell. A sampling mode of operation permits single voltage readings that remain on display until a succeeding sample is taken. (Solartron Laboratory Instruments Ltd., Cox Lane, Chessington, Surrey, England)

Circle 1 on Readers' Service card

Slide projector is available with a zoom lens that permits up to 175-percent change in projection distance or picture size. Focal length is continuously variable from 3.75 to 6.5 in. The lens telescopes to fit the standard carrying case. (Bausch & Lomb Inc., Rochester 2, N.Y.)

Circle 2 on Readers' Service card

Excitation source provides all necessary supply voltages and wave forms for designing, testing, and demonstrating *p-n-p* transistor switching circuitry. The instrument contains three regu-

lated power supplies, a square-wave generator, and output control switches. Two of the power supplies furnish, respectively, 0 to 15 volts, variable, regulated to 200 ma lead, and 12 volts, fixed, regulated to 100 ma lead. The third supply drives the square-wave generator over the range 0 to -12 volts. The generator provides two square waves 180 deg out of phase with each other. Frequency is variable from 5 to 500 kcy/sec. Also available is a push-button pulse generator. (Navigation Computer Corp., Valley Forge Industrial Park, Norristown, Pa.)

Circle 3 on Readers' Service card

Synchro tester is a portable instrument for testing aircraft and missile synchro-transmitter or indicator systems, or both. The instrument embodies a high-speed digital presentation which indicates directly in angle from electrical zero. Over-all accuracy is said to be ± 3 min when used either as a transmitter or receiver. A correction curve permits repeatability to 1 min accuracy. The unit has a self-checking electrical zero transformer with a zeroing adjustment to compensate for minor changes in temperature. (American Machine & Metals Inc., Sellersville, Pa.)

Circle 4 on Readers' Service card

Differential gaussmeter employs dual Hall-effect probes to measure magnetic field gradient. The two probes are held parallel and at a fixed separation by a spacer. They are balanced in a reference magnetic field and can then be rotated at will in the earth's field without affecting the gradient measurement. Full-scale ranges from 0-0.1 to 0-20,000 gauss are covered in 17 steps. Both gradient and absolute field are indicated directly in gauss on a meter or can be fed into an external oscilloscope or recorder. Frequency response is d-c to 400 cy/sec. (Radio Frequency Laboratories, Inc., Powerville Rd., Boonton, N.J.)

Circle 5 on Readers' Service card

Spectrum analyzer covers the frequency range 10 to 1180 Mcy/sec. According to the manufacturer, the analyzer is able to discriminate signals separated by as much as 80 db at 50 kcy/sec separation and by 90 db at 150 kcy/sec separation. Signal sensitivity better than 90 dbm is provided over the fundamental range, 10 to 68 Mcy/sec, and slightly reduced sensitivity is provided to 1180 Mcy/sec with harmonic operation of the local oscillator. Resolution is said to be 5 kcy/sec when signal levels are approximately equal. A built-in, 0.1- and 1-Mcy/sec crystal-controlled calibrator provides markers that allow calibration of the viewing screen at any spectrum-width setting. Photographic, x-y, and roll-chart recording facilities are available. (Lavoie Laboratories, Inc., Morganville, N.J.)

Circle 6 on Readers' Service card

Microwave tracking antenna mount (Fig. 1) designed for field use has handwheels for manual tracking in azimuth and elevation. The mount is available with parabolic, helical beam, and horn antennas. (Automation Dynamics Corp., 255 County Rd., Tenafly, N.J.)

Circle 7 on Readers' Service card

Mass flowmeter consists of a smooth-bore metal tube, a small heater coil, two temperature detecting elements, one downstream and the other upstream from the heater, and a temperature compensator. Heat is injected into the fluid through the wall of the tube and the liquid boundary layer. The down-

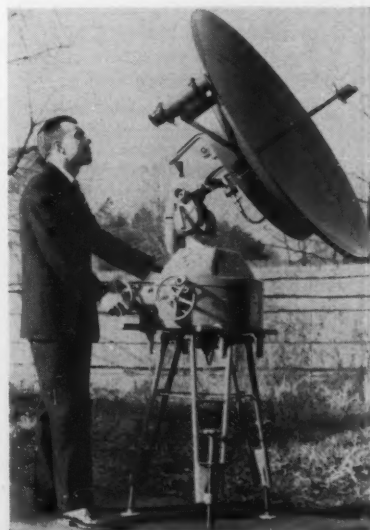
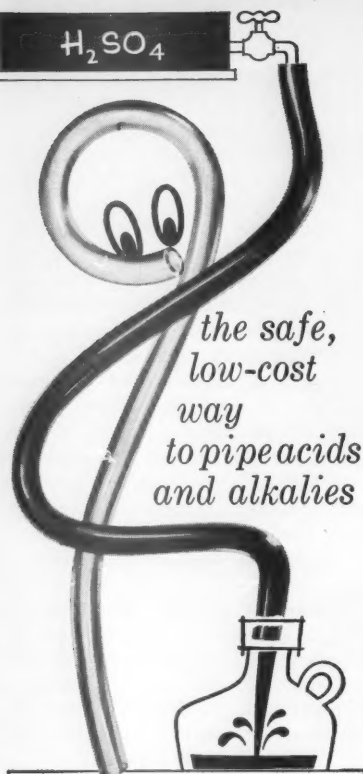
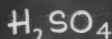


Fig. 1. Microwave tracking antenna mount.

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither *Science* nor the writer assumes responsibility for the accuracy of the information. A Readers' Service card for use in mailing inquiries concerning the items listed is included on pages 423 and 497. Circle the department number of the items in which you are interested on this card.



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stream thermometer measures the resultant temperature of the outside surface of the boundary layer; the upstream thermometer measures initial temperature. Minimum measurable flow is determined primarily by the internal tube diameter; maximum is determined by the effects of turbulence. Accuracy is said to depend on application with ± 1 percent being achievable. Operating temperature range is up to 500°F. (Flow Measurements Corp., 10506 Wheatley St., Kensington, Md.)

Circle 8 on Readers' Service card

Wire bonder (Fig. 2) is designed to bond a wire 0.0002 in. in diameter to a transistor stripe measuring 0.001 by 0.003 in. The wire is positioned on the stripe by maneuvering in the horizontal plane with joystick assemblies and in the vertical plane with a lever. A binocular microscope enables the operator to see the target. Positioning precision of 10 to 15 μ in. is said to be possible. (Kulicke and Soffa Manufacturing Co., 401 N. Broad St., Philadelphia, Pa.)

Circle 9 on Readers' Service card

High-pressure pump (Fig. 3) produces pressures up to 10³ lb/in.² from air at 80 to 100 lb/in.². The pump is a reciprocating type with an output of just over 6 in.³/min at 10⁴ lb/in.², falling to just under 2 in.³/min at 9 \times 10⁴ lb/in.². Pressure is adjusted by means of an air control valve. Pressure may be raised gradually or the control valve may be set to produce the required pressure. The pump is enclosed in a safety cabinet with electrically interlocked doors. The pressure gage is viewed through mirrors. (Charles S. Madan & Co., Ltd., Vortex Works Broadheath, Altrincham, England)

Circle 10 on Readers' Service card

Seismic timer and blaster permits determination of depth to bedrock. Determinations to 100 ft can be made with the timer when an instrumented sledge hammer is used to generate seismic shock waves. The blaster, which greatly extends the range, is a battery-operated, capacitor-discharge type. (Dynametric, Inc., 2965 E. Colorado Blvd., Pasadena, Calif.)

Circle 11 on Readers' Service card

Magnetic-memory drum, the size of a baseball, has a capacity of 358,000 bits with a storage density of 600 bits per inch. Magnetic heads used to store and pick up data are floated on a

0.0001-in. thick film of air on the surface of the drum. The drum, which rotates at about 10,000 rev/min, is suspended on air bearings. Access time is reduced by using a one-word loop. (Sperry Gyroscope Co., Great Neck, N.Y.)

Circle 12 on Readers' Service card

Ball and socket joints of glass use O-rings on the inner member to effect a vacuum-tight seal and are said to require no lubrication. Tubes may be joined within 10° of axial center and may be secured with a standard metal ball and socket clamp. The inner joint member can also be used in combination with standard ground sockets. (California Scientific Glass Co., 9811 E. Rush St., El Monte, Calif.)

Circle 13 on Readers' Service card

Automatic sampling machine (Fig. 4) withdraws a measured volume of the sample from a test tube placed in a locator and transfers the sample with a measured volume of reagent into an empty test tube. To prevent contamination, the sampling pipette automatically follows the lowered liquid level in its downward movement so that only the tip is wetted. As a further precaution, each sample is flushed from the pipette with the reagent. Both the volume of sample and the volume of reagent are preset by the operator. (National Instrument Co., Inc., 4119 Fordleigh Rd., Baltimore 15, Md.)

Circle 14 on Readers' Service card

Recorder control can be used with commercially available potentiometric recorders to set the recorder to any of 15 voltage ranges and any of 15 current ranges, and to change the setting while recording. Auxiliary circuits permit reversal of polarity and check of recorder zero without disturbing or disconnecting the input signal or the recorder. No modification or adjustment of the recorder or the control is required to change from one recorder to another. Ranges are 10 mv to 500 v, and 10 μ a to 500 ma, full scale, on a 10-mv recorder. Output resistance as seen by the recorder is 1000 ohms (max.). Input resistance for voltage measurement is 100 kohm per volt of decade switch setting, 1 megohm/volt with a 1-mv recorder; for current measurement, input resistance is 1000, 100, or 10.0 ohms, depending on decade switch setting. (Cahn Instrument Co., 14511 Paramount Blvd., Paramount, Calif.)

Circle 15 on Readers' Service card

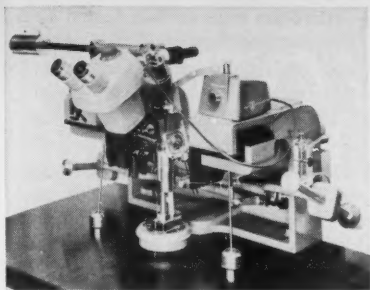


Fig. 2. Wire bonder.

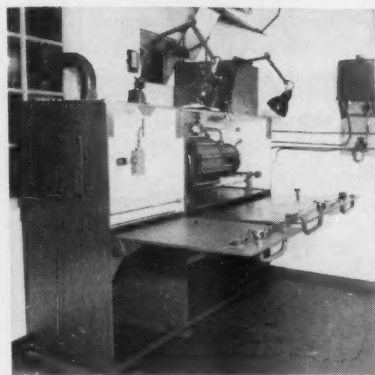


Fig. 3. High-pressure pump.

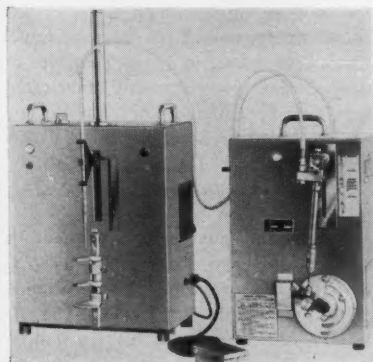


Fig. 4. Automatic sampling machine.

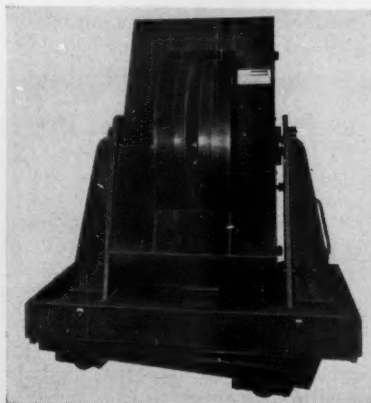


Fig. 5. Electromagnet.

Differential conductivity meter is designed to measure, indicate, and transmit to a remote recorder the difference in solution conductivity at any two locations. Independent temperature compensation is provided for the cells at the two locations. The instrument incorporates two complete and independent self-balancing Wheatstone bridges. Three indicating scales are provided, two for the individual conductivities and one for conductivity difference. Electrical or pneumatic transmitters can be provided for remote recording. Temperature compensators may be manual or automatic. (Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N.J.)

Circle 16 on Readers' Service card

Electromagnet (Fig. 5) provides a field of 51.5 kgauss with 1/2-in. gap and 1 1/2-in. diameter pole pieces. Distance between coils as well as gap can be varied. Pole tips may have a maximum diameter of 18 in. A field of 40 kgauss is attained with 1-in. gap and 6-in. diameter tips; 35 kgauss with 2-in. gap and 6-in. tips; 10 1/2 kgauss with 4-in. gap and 18-in. tips. Maximum power is 200 kw with low-impedance coils and 12 kw with high-impedance coils. Vertical and horizontal rotation are provided. (Pacific Electric Motor Co., 1009 66th Ave., Oakland, Calif.)

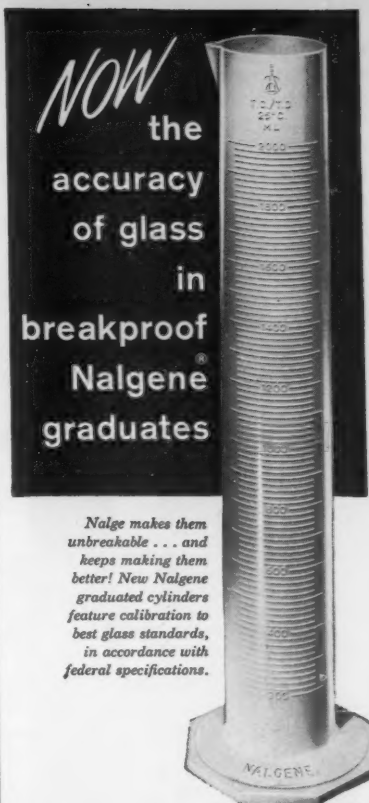
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Strip-chart recorder of the moving-coil type is said to be accurate within ± 1 percent. The writing system may be ink pen, hot wire, or electrosensitive paper. Standard chart speeds of 1/2, 1, 6, or 12 in./hr or in./min may be changed by replacing wheels in a gear train. Dual-speed chart mechanisms are also available. A variety of voltmeter and ammeter ranges are available for both a-c and d-c. Response time is said to be about 0.6 sec. (Atkins Technical Inc., 1276 W. Third St., Cleveland 13, Ohio)

Circle 18 on Readers' Service card

Annunciator display has a capacity of 60 messages that may be displayed individually or in combination. The device operates on a rear-projection principle providing 60 lenses that are used for data or color background. The display features one-plane presentation. Overall size is 5 1/4 by 12 by 16 1/2 in. (Industrial Electronic Engineers, Inc., North Hollywood, Calif.)

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are available. Construction material in addition to tungsten includes alumina and 304 stainless steel. (Winsco Instruments & Controls, 11789 W. Pico Blvd., Los Angeles 64, Calif.)

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Composite seal is a stainless-steel V-ring combined with a fluorocarbon-plastic seal. The composite is designed to operate at temperatures from -65° to $+600^{\circ}\text{F}$. The units are re-usable. (Pall Corp., 30 Sea Cliff Ave., Glen Cove, N.Y.)

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Microfilm recorder is actuated by information supplied by a computer to make multiview drawings of parts to be fabricated. Once the engineering specifications for the part are fed in, the computer can be asked to produce drawings of any view or cross section of the part in three dimensions. The same computer code used to produce the drawings can also be used to produce tapes for operation of automatic production equipment. Information is recorded on 35-mm microfilm. Printing is accomplished by photographing displays on the face of a Charactron shaped-beam tube. An accessory unit permits automatic processing and projection of the film on a 2- by 2-ft screen within 8 sec. (Stromberg-Carlson Div., General Dynamics Corp., P.O. Box 2449, San Diego 12, Calif.)

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Binary-coded decimal-to-decimal converter is the first of a series of modular solid-state devices constructed by simultaneous fabrication of multi-element components. The device contains 40 silicon diodes and is designed to drive an indicator tube directly from binary-coded inputs. In the manufacture of the units, a single silicon wafer is diffused to form a large planar diode. From this wafer, as many elements as desired are simultaneously fabricated in a specific pattern. The resulting array is joined to a circuit plate. (Burroughs Corp., Plainfield, N.J.)

Circle 23 on Readers' Service card

Strain-gage auxiliary instrument is a miniature device that contains a signal amplifier, power supply, bridge-balance circuits, and calibration circuits. The latter can be programmed from a remote source. Four reference points are provided, and polarity of the calibration can be reversed to simulate compression or tension of a strain gage. Signals are amplified to a maximum output of ± 5 volts d-c., and output impedance is 350 ohms. (Video Instruments Co., 3002 Pennsylvania Ave., Santa Monica, Calif.)

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Cryogenic thermometer measures temperature in the range of 0.3° to 25.0°K . The instrument operates by measuring mutual inductances as small as 2×10^{-4} by use of an a-c bridge circuit and ruby crystals. Bridge current is supplied by a modular signal generator tuned to 155 cy/sec. Bridge output is amplified by a transistorized narrow-



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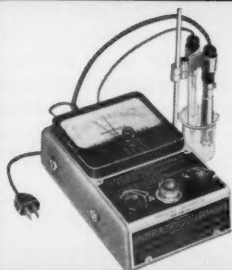


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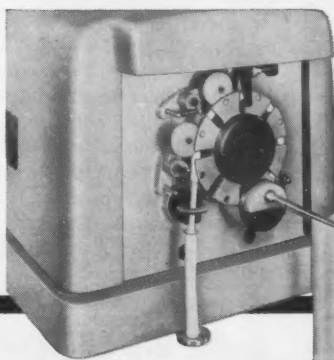
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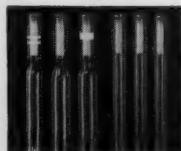
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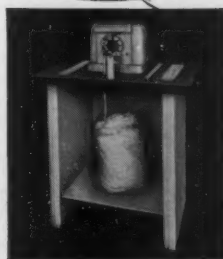


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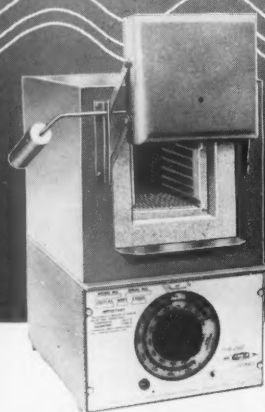
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crossover occurs without gaps or overlapping and without shift in wave-number indication. Scanning rate can be varied from 65 sec for the entire range to 4.5 min per wave number. Accessories developed for use with other instruments can be used with model 421. Wavelength coverage of the far infrared can be added by suitable prism interchanges. (Perkin-Elmer Corp., Norwalk, Conn.)

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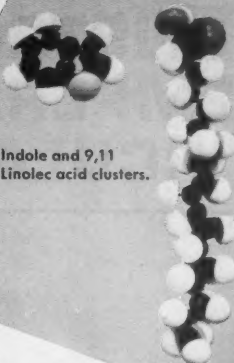
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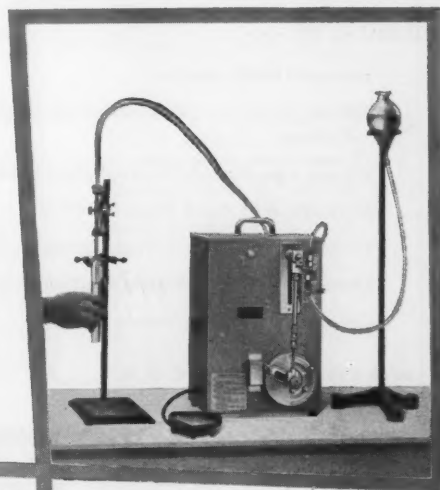
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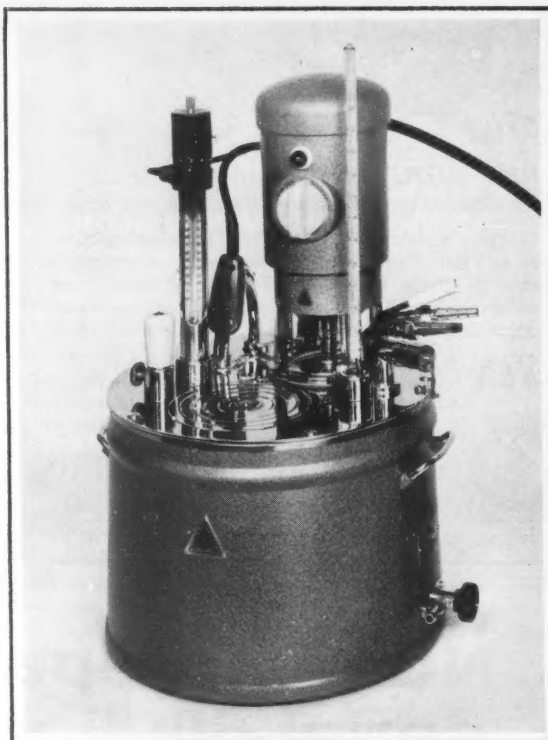
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Letters

Project Chariot

In a recent issue of *Science* [133, 2000 (1961)] there appears an article by Howard Margolis about the separate reports on Project Chariot (the AEC proposal for underground explosions at Cape Thompson, Alaska) issued by the AEC and by the St. Louis Committee for Nuclear Information (CNI). Margolis' comments on the CNI report comprise the following items: (i) a summary of the contents of the report; (ii) an account of supposed "technical errors" (only one is mentioned) in the report and Margolis' criticism of certain of its conclusions; (iii) Margolis' own statement regarding the relative risks to Alaska Eskimos from radiation due to television watching, current levels of fallout, and the fallout that might result from Project Chariot.

In our opinion Margolis' discussion of the contents of the CNI report is incomplete, inaccurate and misleading. Item 3, which represents Margolis' own effort at analyzing radiation risks, is simply incorrect. To support these views we submit the following:

Margolis' summary of the contents of the CNI report is incomplete in a number of important respects. Among the observations made in this report, and absent in Margolis' account of it (and also absent from the AEC report on Project Chariot) are the following:

1) The basic data (the results of four underground nuclear explosions in Nevada) on which the AEC estimates of the total amount of radioactive debris which the Chariot explosion is expected to eject into the air, are inadequate for this predictive purpose. This is noted in an AEC technical report (UCRL 5676, p. 21, quoted in the CNI bulletin) which states: "From these four events it is obviously a great stretch of one's imagination to predict a great deal about the variation of crater width as a function of nuclear yield and depth of burial." The AEC prediction that 5 percent of the proposed Chariot explosion's total radioactivity will be vented into the air is based on an inter-

polation between two points in the four-point curve which describes the results of the foregoing test explosions. The two points which anchor this interpolation have the values 90 percent and 1 to 2 percent venting of total yield; the theoretical curve drawn between them (for which no mathematical basis is given anywhere in the available AEC literature) is a steeply concave curve. That reliance on such a curve does not meet the ordinary standards of scientific evidence will perhaps be most clear to the readers of *Science* from examination of the accompanying Fig. 1. The CNI report concludes that, given these data, the radioactivity ejected into the atmosphere by the Chariot explosion might with ap-

parently equal probability be anywhere from 1 to 25 percent of the total radioactivity. The more volatile reaction products will be more efficiently vented, and a general factor of 4 to 5 is used by AEC investigators to estimate strontium-90 enrichment for this reason (UCRL 6249T, p. 11). However, this factor must be rather imprecise, for it is affected by the parameters that govern the physical events in an underground explosion—which are, as we have seen, still poorly understood. A 5 percent general venting (the AEC prediction) therefore implies 20 to 25 percent Sr^{90} venting and 25 percent general venting (our suggestion of what is possible) implies that a completely vented yield of Sr^{90} apparently cannot be excluded.

2) AEC calculations of the shape of the fallout zone, which depend strongly on wind velocity, are based on winds measured at Kotzebue, 120 miles from the site of Project Chariot. However, as reported in the AEC report on Project Chariot (p. 45), the average peak wind speed at the actual Chariot site (Ogotruk Creek) was 65 mi/hr, at a time when the corresponding value

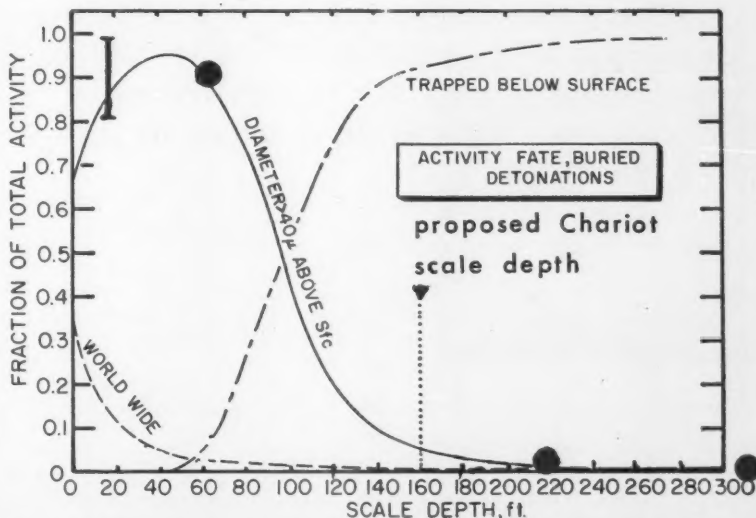


Fig. 1. This figure is taken from a paper by M. A. Harrison ("Excavation with nuclear explosives") in *Proceedings of the Second Plowshare Symposium, II*, UCRL-5676, to which we have added four points, and a dotted line indicating the scale depth of the proposed Chariot explosion. The values of the four points, which represent the actual data from past underground explosions (Jangle-U, Teapot-S, Neptune, and Blanca, in order of increasing scale depth) are taken from a paper by G. W. Johnson ("Excavation with nuclear explosives," UCRL-5917). The value of the scale depth of the Chariot explosion, as presently proposed, (160) is also taken from Johnson's paper. The point at issue is how well the curve relating vented yield (the solid curve, marked "Diameter $> 40 \mu$ above sfc.") to scale depth can predict the vented yield at scale depth 160. The AEC prediction of 5 percent vented yield is represented by the point at which the curve crosses this scale depth. In the CNI report on this problem, it is pointed out that a number of curves can reasonably be drawn between the four points which represent the actual data, which will indicate, at scale depth 160, any value up to 25 percent vented yield.

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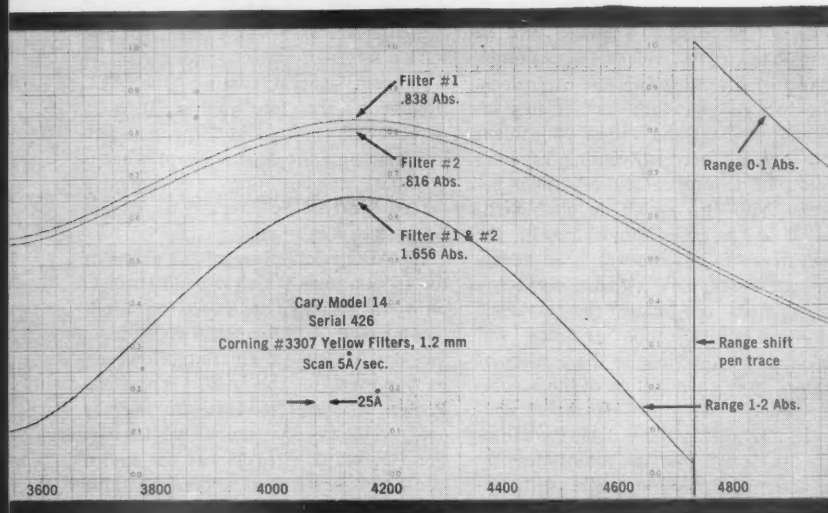
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for Kotzebue was 19 mi/hr. Since wind velocity has a decisive effect on fallout distribution, the AEC estimates of the fallout pattern must be in error.

3) Although fallout on the ground in northern Alaska from past nuclear tests is very low compared to that in temperate zones, the Sr^{90} levels of caribou and of the few Eskimo bones that have been analyzed thus far are much higher than the values for cattle and people in temperate United States. The CNI bulletin reports data which show that this is due to the unusual mineral nutrition of lichens. This remarkable situation is not mentioned in the AEC report, though we were pleased to learn recently that the responsible officials are now taking steps to institute a research program on the problem.

4) The CNI bulletin contains eight pages of detailed discussion, written by the biologists who investigated the problem for the AEC, of the unusual food chain in the Arctic (lichen-caribou-man). This discussion shows that predictions of biological Sr^{90} distribution based on the temperate-zone food chain (grass-cow-milk-human) do not apply to Alaska. Nor is the ecological behavior of Sr^{90} in tropical environments applicable to Alaska. Nevertheless, the AEC report on Project Chariot states that "possible radiation effects upon the biota of the Chariot site have been estimated from the Nevada Test site and the Pacific Proving ground data" (p. 55).

Margolis states that AEC officials believe "that the CNI assertion that the Sr^{90} yield might be ten times greater than the AEC believed likely was based on misreading of an AEC sponsored study. The study gave 5 percent as the most probable portion of the total radioactive yield that might get into the fallout." Margolis himself finds fault with the CNI conclusion and endeavors to show that at most the AEC estimate of fallout is low by a factor of 4 rather than by the factor of 10 suggested in our bulletin. As stated in the CNI report, the factor 10 is derived from two sources: a possibly fivefold underestimation by the AEC on the vented yield (which is explained above) and an estimated twofold error regarding the pattern of fallout deposition. The factor of 5 has been discussed already. The other factor of 2 can arise if the winds at the Chariot site are stronger than the values used in AEC estimates of the fallout pattern. Stronger winds could blow more of the fallout away from the immediate site (which can be



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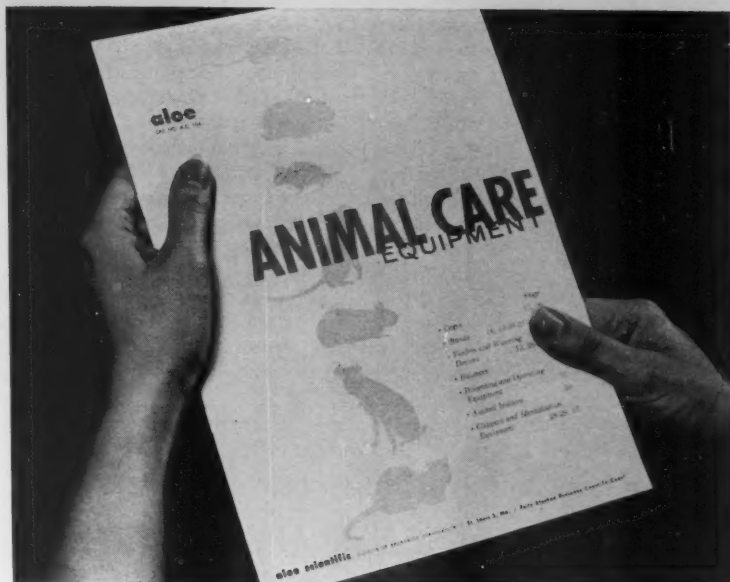
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closed off from animals) and further downwind where it becomes accessible to the food chain. Of course, if the intensity downwind should rise the intensity at the site must drop accordingly, but for the reasons stated we are mainly concerned with some distances downward from the site. It seems reasonable that these effects could increase the AEC estimate of the downwind deposition of fallout by a factor of 2, because the wind velocities at the Chariot site tend to be significantly higher than the value used in the AEC estimate.

Margolis states on his own authority that "As it happens, the exposure from habitual television watching, or from current levels of fallout, is roughly the same as the exposure the 700 Eskimos might receive if pessimistic assumptions about the absorption of Sr^{90} are correct." Now, this sentence would be roughly correct if Margolis had added as an important condition, that the statement refers only to the effects of these three sources of radiation on the gonads. If Margolis were to amend his statement in this way it would then be technically correct, but still quite misleading to a reader interested in comparing the relative risks to his health from these three sources, because it fails to mention the risks to the bone marrow from these sources of radiation. It is an elementary fact now well established in the relevant literature that the risk from fallout radiation is of two kinds: (i) a genetic risk of deleterious mutations due to exposure to the gonads, and (ii) a somatic risk (from leukemia and other forms of cancer) due chiefly to irradiation of the bone marrow. The gonadal exposure is due to cesium-137; the marrow exposure is due to Sr^{90} . All published comparisons [see for example, the report of the British Medical Council, *The Hazards to Man of Nuclear and Allied Radiations* (Medical Research Council, HMSO, London, 1956)] of the radiation risk from television watching and from fallout refer only to gonadal exposure for the simple reason that while television watching may lead to a maximum of 1 mrem of exposure to the gonads per year, it has no measurable effect on the bone marrow, because the radiation is too soft to penetrate more than a few millimeters of body tissue. Hence any estimate of the risk from Sr^{90} , which necessarily refers to an effect on the marrow, will be incomparably greater than the hazard, to the bone marrow, of television



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watching. It will be noted that Margolis' comment also includes a statement of equality between exposure to Eskimos from current levels of fallout, and from Sr^{90} that might result from the Chariot explosions. The exposure to Eskimos from present fallout is approximately known (about 1 to 3 μC of Sr^{90} per gram of calcium in the bones; see *Radiological Health Data*, Jan. 1961, p. 21). We would expect Margolis to show, in support of his statement, that the Sr^{90} that Cape Thompson Eskimos might absorb from the Chariot explosion also amounts to about 1 to 3

μC of Sr^{90} per gram of calcium in the bones. We suggest that he produce such calculations. For our part, after careful study of the available data, we concluded, as stated in the CNI report, that there were not sufficient data about the relevant parameters (for example the mineral nutrition and feeding habits of the caribou; the total Sr^{90} in the Eskimo diet) to warrant such a calculation.

None of the foregoing observations are adequately represented in Margolis' account of the CNI report on the Chariot Project. Nevertheless, Margolis

had ample opportunity to become acquainted with these matters in advance of the preparation of his article. A few days after the CNI report had been made public, one of us received a long distance telephone call from Margolis. In this call he made several criticisms of the CNI report, and asked for comment on them. During this conversation Margolis acknowledged that he had not yet seen a copy of the CNI report. Accordingly, a copy of the report was sent to him immediately. After several days he called again. In this second conversation nearly all of the points which we have enumerated above (including an explanation of the so-called "technical error") were explained to Margolis at some length. We regret that they do not appear in his article. In particular, we believe that ordinary journalistic practice would recommend that the specific reply given to his query about the supposed technical error in the CNI report should appear in his article alongside his discussion of the AEC "complaint" about it.

We should also like to note that the quotations which Margolis attributes to "a spokesman for CNI" do not precisely reflect what was said to him, and it is pertinent that he neither asked for permission to quote (which would have readily been granted) nor checked the quotations with their source.

The foregoing comments explain why we believe that Margolis' article on the reports about Project Chariot is incomplete, misleading, and in some respects quite incorrect.

BARRY COMMONER
M. W. FRIEDLANDER
ERIC REISS

St. Louis Committee for Nuclear
Information, St. Louis, Missouri

In reply to the CNI letter:

1) The bulk of my article, contrary to the impression given by CNI's letter, was not concerned with CNI's technical errors or with my own predictions of radiation levels, but with the likelihood that the CNI report would mislead rather than inform the public on the central question of the magnitude of the fallout risk.

2) With regard to the material dealt with in the letter, much of it is simply a recounting of parts of the CNI report, and this recounting does not conflict with the summary of the report I gave in my article. Other parts are attacks on the AEC, to which I assume the AEC will reply if they deem it worthwhile. I should point out, though, that

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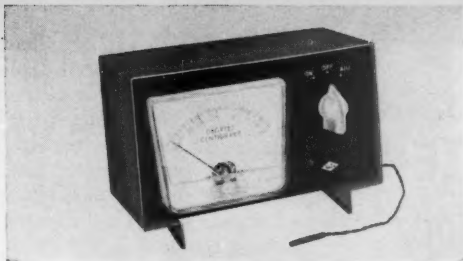
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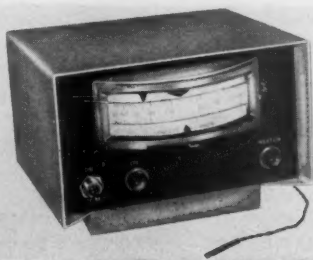
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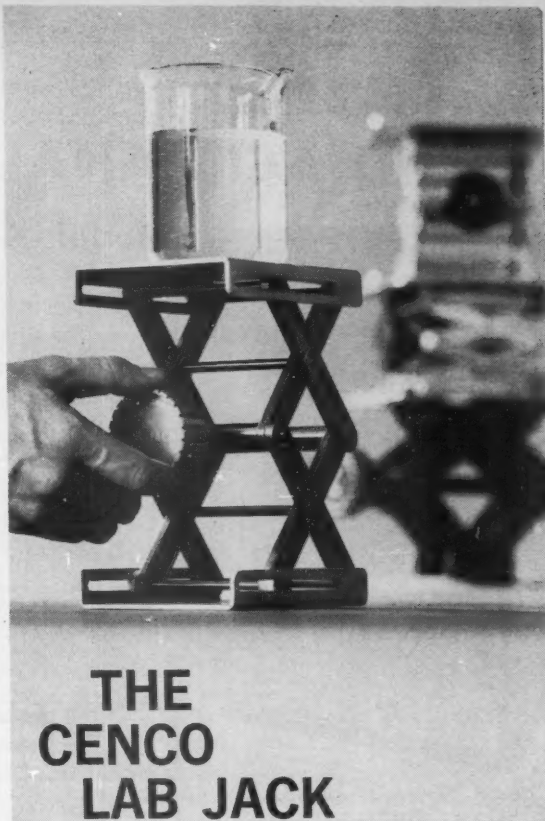
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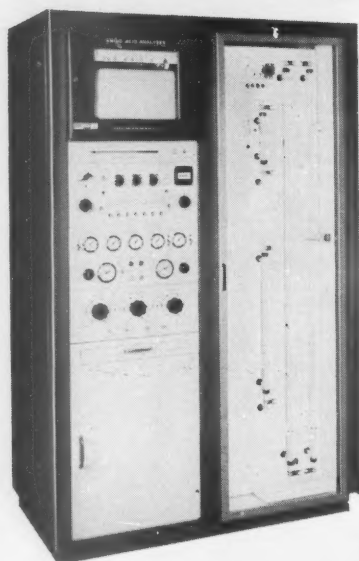
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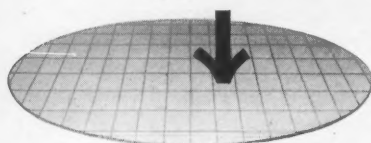
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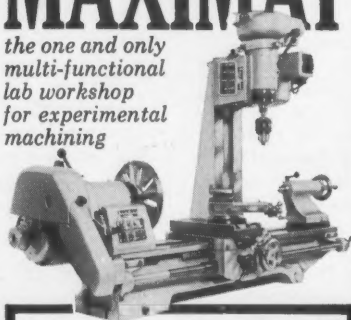
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the CNI summary of what the AEC said and did is not always, indeed is rarely, quite the same as what the AEC said and did. For example, the AEC began contracting for studies of the food chain, including the absorption of strontium, nearly 2 years ago, and indeed a good deal of the material CNI cites was developed as a result of studies sponsored by the AEC.

3) On the technical points directly questioning the reliability of my article: I don't see how CNI argues that it has not erred in its handling of the AEC fallout figures. The pertinent AEC report clearly states that its estimates are based on an assumed fivefold enrichment of Sr^{90} (not four- to five-fold, as stated in CNI's letter). The AEC prediction for the most probable average venting of fallout was 5 percent, and for Sr^{90} , 25 percent. Obviously CNI's report, which postulated a further fivefold increase in Sr^{90} , must be wrong, since the fallout can hardly contain more than 100 percent of all the Sr^{90} produced by the test. Further, Dr. Friedlander, in calculating CNI's estimate of the average Sr^{90} deposit throughout the zone, simply multiplied the AEC estimate by 10, and although CNI might well argue that the deposit "some distance downwind" might be 10 times the AEC estimate, the average deposit throughout the zone can hardly, for the reason noted above, be off by more than a factor of 4.

CNI is correct in criticizing my handling of the television example, although if readers will refer to my article I think they will find that the error is not as significant as CNI implies. What is curious is that CNI itself has included a grosser form of this same error in its own report. CNI does not inform its readers that there is no danger of genetic damage from Sr^{90} , but actually includes a reference to the possibility of genetic damage. Further, Dr. Commoner's article in the CNI report, in giving figures on the generally recommended guide lines for Sr^{90} absorption in humans, does not give the figure for Sr^{90} (67 units) but instead gives the figure for whole body exposure (including, of course, the gonads) and announces that "this corresponds to about 17 strontium units in the bone." Thus CNI misleads its readers into believing the generally accepted guide line is smaller by a factor of 4 than the actual figure, and this is done by applying the whole body rate, deliberately set this low because it includes genetically dangerous exposure, to calculate a rate for

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bone marrow, where the danger is solely somatic.

This ties in with CNI's complaint about my statement that the probable increase in Sr^{90} in the 700 Eskimos, under pessimistic assumptions, would be about equal to present levels. CNI gives the current level of strontium in Eskimos as 1 to 3 units. This is based on a total sample of six. The values are: an infant (2.42), a 7-year-old (3.35), and four adults (0.18; 1.94; 0.47; and 0.59). Aside from the small sample size, it is difficult to know what would be a fair average calculated from this data to compare with the National Committee on Radiation Protection guide line, which is 67 units for an average for individuals within a population, and three times this, 200 units, for a single individual within the population. The levels for very young children are higher since they have been exposed to a given level all their lives. If, as with the Chariot test, the level is not to be kept up by continued testing, the level in the children will fall as they grow. This makes the CNI calculation seem somewhat excessive, but if we accept their figure of 1 to 3 units as the range for the average figure and compare it with the relevant NCRP guide line (67 units), then the current levels would be about 1/67 to 1/22 of the guide line. Even under the assumptions in the CNI report this seems unlikely to be increased more than several times, if that much, and the increase, like the base, will be some small fraction of the guide line, in other words (to repeat my error) an increase "roughly the same" as current levels.

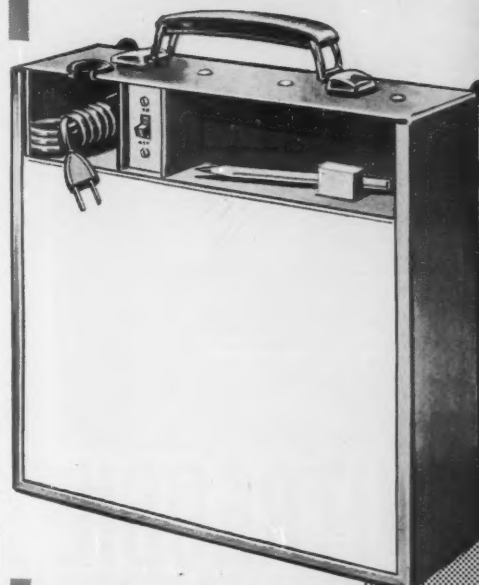
The point of my comparison of the potential increase, under pessimistic assumptions, with exposure from television and current levels of fallout was not to imply that the type or amount of radiation was precisely the same, but to give the reader a general idea of the magnitude of exposure involved, in contrast to the CNI report which talked repeatedly in terms of "great uncertainty" concerning the harm that might be done, of the fallout "sealing off Cape Hope," of "little margin for error," and which, in general, could not have been better phrased to scare the daylights out of the lay audience for which it was written.

4) Finally, I must insist that my article reflects quite precisely Dr. Commoner's responses to my questions concerning the misleading nature of the CNI report.—H.M.

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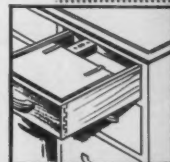
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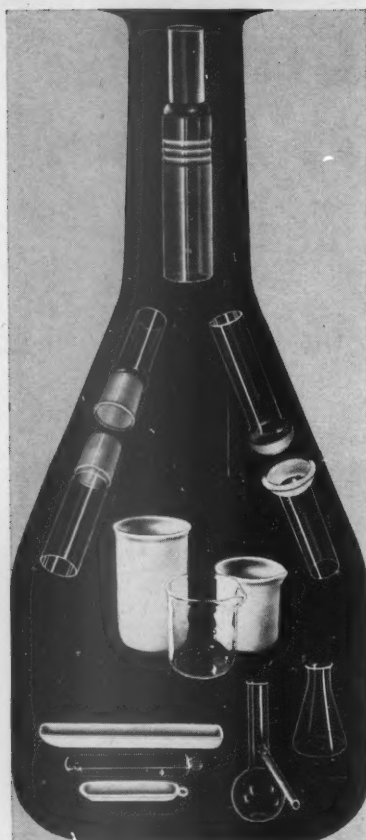
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Some years ago an article appeared in which the merits of printed "reprint-request" postcards were closely examined [J. Hedgpeth, *Am. Scientist* 42, 497 (1954)]. Rather few of the cards' alleged merits withstood the author's critical scrutiny. The cards were adjudged discourteous, inconsiderate, and generally to be abhorred. In fact, I was sufficiently impressed by the fire of condemnation to forswear the use of such contemptible missives. Subsequently, each of my reprint requests was accompanied by a carefully worded letter of justification. Unfortunately, this habit was shattered by the disillusionment that resulted when I and several colleagues at Yale received smudged, printed reprint-request postcards from several of the same knights who had joined in challenging the boorish reprint collectors. Sad is the life of the idealists!

In recent months the need for renewed attack has become acute. To pass over, for the moment, the dozens of mailings to anonymous collectors that the cards demand, there are now appearing increasing numbers of cards requesting two reprints. "one for me and one for my library." When each of the two workers at an arctic research station sent me such a card the dam was breached, and this flow commenced. Perhaps these men were merely lonely and wanting to encourage correspondence. Perhaps their months of solitude in bitter arctic wastes had caused each to retreat from contact with the other (but two libraries?). In the face of such a pattern, however, it is clear that the most economical solution would be to abolish all journals and to offer all articles for sale as separates. Could the alternative proposed by Hedgpeth also be prayerfully reconsidered?

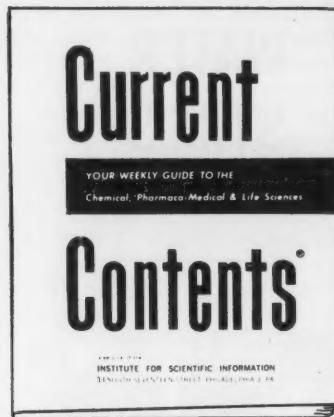
PETER H. KLOPPER

Department of Zoology, Duke
University, Durham, North Carolina

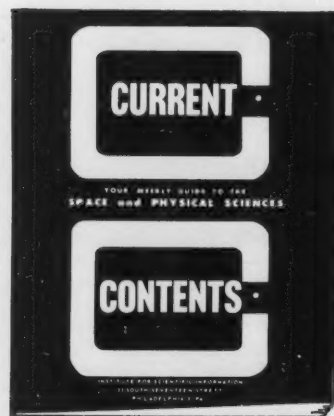
Repetitive Self-Stimulation

Since Olds and Milner described the repetitive self-stimulation by rats with electrodes implanted in their brain, there has been increasing acceptance of the concept that this self-stimulation is of a rewarding nature. Certainly it is understandable how this view has arisen, but I submit that this

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SCIENCE, VOL. 134

is not quite the correct significance of the phenomena observed. To equate this self-stimulation with reward is to equate it with a consummatory act. A consummatory act is accompanied by gratification and is followed by quiescence and by cessation of appetitive or searching behavior. Prior to culmination of the consummatory act an animal continues to search incessantly for gratification. This is manifested as "repetition compulsion" in myriad forms resembling the self-stimulation phenomenon. A rat, for instance, may copulate 50 times in rapid succession but stops after ejaculation.

From the physiological as well as the psychological standpoint it would appear that this self-stimulation has to do with the "promise of a reward," with a productive phenomenon anticipating the consummatory act. The questions to be asked are: Does it lead to cessation of the specific behavior? Is it followed by relaxation and sleep? Does a new form of behavior develop upon awakening? If an animal were to be stimulated in such a way that this sequence of events were to occur, we could properly refer to such stimulation as involving a reward system. (For comparison, consider the case of the donkey with a carrot held out in front of it. The Olds-Milner system never allows the donkey to get the carrot.) Otherwise we should continue to employ the term first used by Olds and Milner: *positive reinforcement system*.

WILLIAM J. TURNER

Central Islip State Hospital,
Central Islip, New York

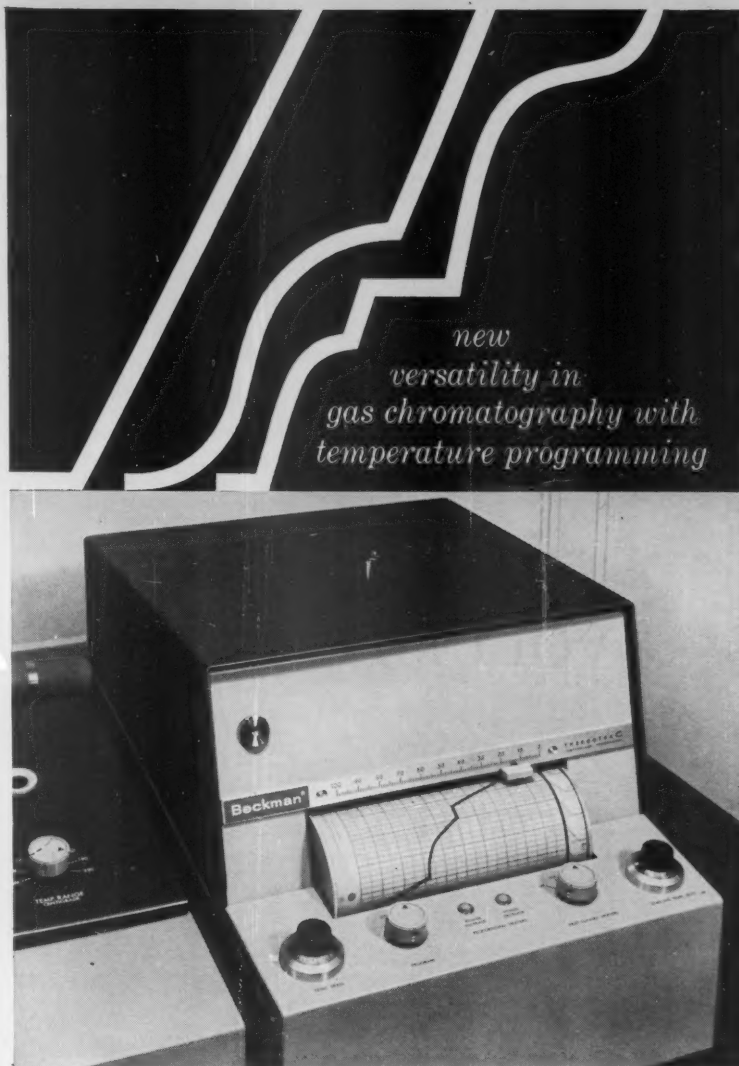
Letters in "Science"

I hope you will permit a reader from foreign parts to offer his thanks to Conway Zirkle for writing the letter on degrees and titles [*Science* 133, 1626 (1961)] and to you for publishing it. The activities of the Society for the Rationalization of the Title of Doctor cannot be too widely known. And while I am about it, thanks also to Kirby Walker for his letter, in the same issue (p. 1648), on books as prestige objects.

To those of us who spend our lives contemplating the dreary acres of scientific literature unrelieved by a spark of wit, it is a real joy to read such correspondence in a scientific journal.

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The Yellin Case

A recent editorial, "One in eighteen thousand" [*Science*, **133**, 2037 (1961)], begins with the words: "For many scientific purposes an event that happens only once in ten or twenty thousand tries is statistically insignificant. . . . But in other cases, the focus of interest may be on the unusual event itself. . . ." That editorial represents for me just such an unusual event, since it is the first time that I have found an idea proposed by an editor of *Science* so

repugnant and outrageous as to compel me to express myself in the form of a "letter to the editor."

I refer, of course, to the suggestion that: "To minimize the chance that so rare an event [the Edward Yellin case] will occur again the [National Science] Foundation need only include on its application form a question about the criminal record of the candidate."

I do not know what proportion of the members of the scientific community have criminal records, but I would guess that such individuals must

be rare, indeed. Furthermore, to my knowledge, there is no evidence whatsoever that such persons, as a group, have demonstrated any lack of scientific ability, even if that term is interpreted to include such qualifications as "motivation, independence, objective judgment, accuracy, and integrity" in their scientific endeavors.

On the other hand, the National Science Foundation, and all other granting agencies, recognize that some small percentage of funds granted for scientific investigations is used illegally by scientific charlatans for their own furtherance or aggrandizement. Again however, there is no correlation, to my knowledge, between that group of persons engaging in such unfortunate activities, and the hypothetical group of investigators with previous criminal histories. Until such a significant, positive correlation has been demonstrated, it seems to me that the editor's suggestion is, at the very least, irrelevant.

Irrelevance is a sufficient reason not to accept a suggestion. However, I do not find this idea repugnant primarily because it is irrelevant, but because it is one more manifestation of a trend in present-day society to suggest, and sometimes even to accept, protestations and oaths of loyalty, purity, and moral righteousness in place of such qualities as capability, originality, and creative thought.

ROBERT L. DEHAAN

3003 North Calvert Street,
Baltimore, Maryland

Your proposal in the editorial, "One in eighteen thousand," that National Science Foundation fellowship application forms include a question concerning the candidate's record of criminal convictions is reasonable enough, but it fails to touch on the central issue raised by the Yellin case—freedom of the individual conscience and the privacy of ideas.

National Science Foundation officials would not have had to face the stern inquisitors of the House Un-American Activities Committee if they had awarded a fellowship to an individual previously convicted of the common crime of embezzlement or bigamy. Yellin's offense was to invite an indictment for contempt of Congress by refusing to answer the House Un-American Activities Committee's questions about his past political associations on the grounds that this committee's investigation was an encroach-

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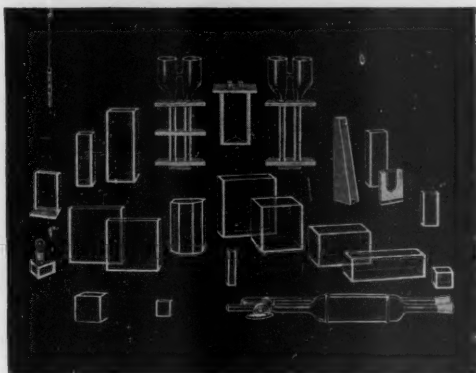
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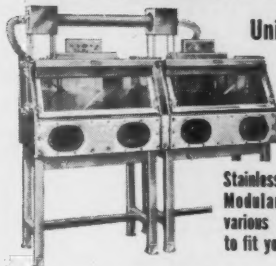
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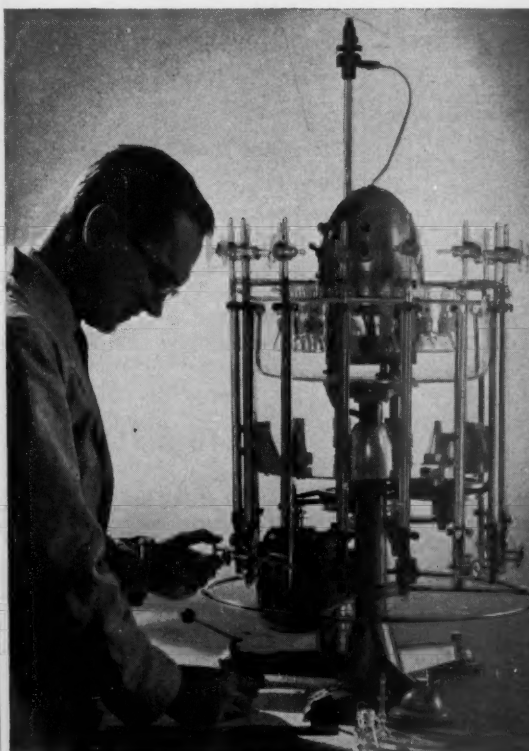
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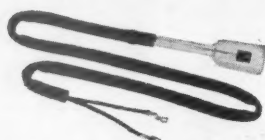
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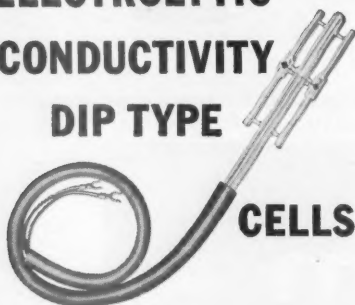


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ment of his constitutional rights of free speech and assembly guaranteed by the First Amendment. Yellin could easily have avoided serious difficulty with the committee and the citation for contempt by refusing to cooperate with the committee as hundreds of others have done in recent years by standing on the Fifth Amendment.

Yellin's challenge of the committee's right to probe the political beliefs of our citizens was undertaken with the clear knowledge that this action could result in his imprisonment. His decision to undergo this risk is in the highest traditions of our nation. It was awareness of this, I am sure, that helped Yellin win his reinstatement as a student after a hearing by the investigating committee of the University of Illinois.

Several years ago, an application for financial support of a research project on leukemia was rejected by an agency of the Public Health Service because the principal investigator, Linus Pauling, had failed to obtain the necessary political clearance. Public opposition to this unwarranted interference in research now makes it unnecessary for an investigator to undergo political screening to obtain a federal grant for a project in the health sciences.

Protection of freedom of thought is particularly important to us as scientists. It would be harmful to all of us if political clearance became a necessary condition to obtaining a federally supported fellowship.

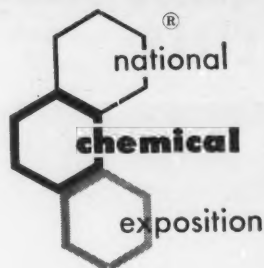
MONROE SCHNEIDER

*Jewish Chronic Disease Hospital,
Brooklyn, New York*

Krebiozen

We read with interest your notes on the Krebiozen trial [*Science* 133, 1345 (1961)], which included reference to the Citizens Emergency Committee for Krebiozen.

If any further proof were required as to the validity of your statement that "professional sentiment in the field is overwhelmingly against Krebiozen," it is furnished by your most liberal application of the noun *scientist* to George D. Stoddard in connection with his criticism of the work of Andrew C. Ivy. Indeed, a large question involved in the litigation of Ivy versus Stoddard is that of freedom of research and inquiry in America. But to imply that a "scientist" in the field of education is qualified to criticize the work



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of, and imply professional incompetence on the part of, a physiologist in the highly specialized field of cancer research is ludicrous, to say the least.

RHODA BOYKO

Citizens Emergency Committee
for Krebiozen, New York, New York

According to American Men of Science, Stoddard is a former head of the department of psychology at the University of Iowa. In recent years he has held administrative posts, and he is now chancellor of New York University.—Ed.

Mathematics Degrees

I noted with interest the editorial on the proposed Doctor of Arts degree for noncreative mathematicians [Science 133, 1979 (1961)]. I commend you for publishing it.

I would urge, however, that it may be equally productive to consider a more restricted designation than the current Ph.D. for programs which stress the creative aspects of a discipline more than a scholarly treatment of its substance, structure, and relation to other fields of knowledge. For the former group, the Doctor of Mathematics might be appropriate.

H. CRAIG SIPE

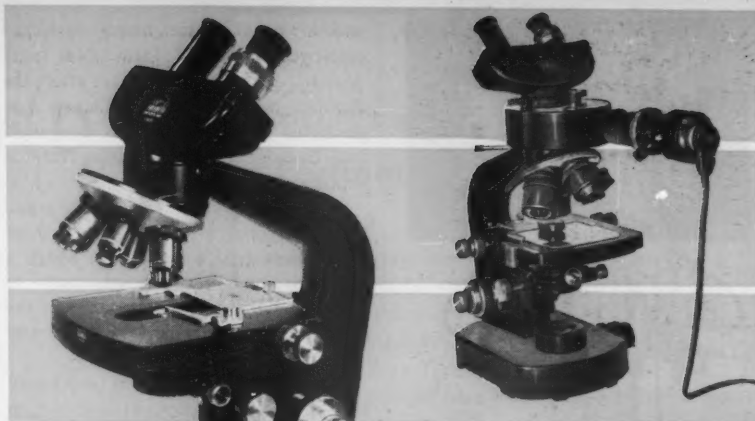
George Peabody College for Teachers,
Nashville, Tennessee

Communication between Social and Physical Scientists

In the 12th to 14th paragraphs of the New York Times obituary of the Soviet physicist Kurchatov (8 February 1960), the following sentences appeared (p. 4).

"One of Dr. Kurchatov's most significant public statements came in early 1958 when he publicly asserted that it was the Soviet Union, not the United States, that invented the hydrogen bomb. . . .

"That the Academician's claim may be correct has been indicated by evidence published in this country that the Soviet 1953 thermonuclear explosion was accomplished with the use of a form of lithium deuteride as a solid. This evidence suggests that the November, 1952, American thermonuclear device had to be very bulky because it contained much refrigeration apparatus



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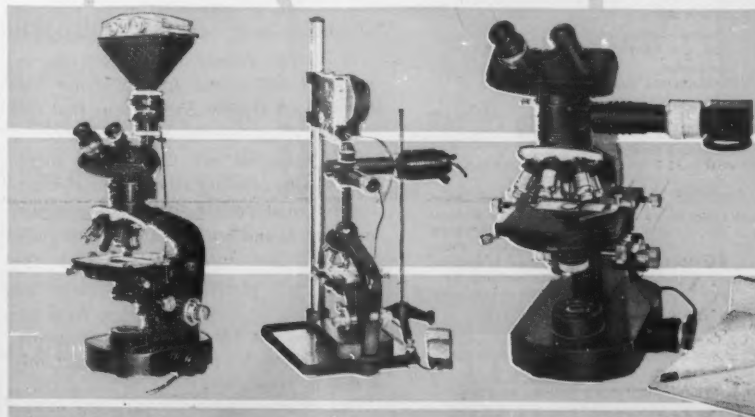
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needed to keep the heavy hydrogen employed in liquid form. Not until March, 1954, a half year after the Russian explosion, the evidence suggests, did the United States explode a real hydrogen bomb utilizing lithium deuteride."

If it was news that the Russians had the first hydrogen bomb and that there was a period of 6 months in which a hydrogen-bomb gap existed, then, as the following comments suggest, the news was—and remains—quite well hidden.

An informal survey was conducted among social and physical scientists in the Cambridge, Massachusetts, area. Quite universally social scientists had not previously known that there had been an apparent 6-month hydrogen-bomb gap in Russia's favor, and what is more, although they professed to having read the *Times* story, they (again quite universally) had not appreciated what was being reported. Some of these persons, it might be noted, teach and write about international (and particularly military) policy.

Physical scientists, on the other hand, did not see the matter as news. Quite universally they had "here or there" picked up the information given in the story, and, what is more, they expressed surprise that it was, in some quarters, news.

At least two points are worthy of further consideration. First, the story, which if news was surely one of the most important stories of the postwar period, was not picked up, given headline status, or made any sort of national issue by those (congressmen, commentators, and so on) who make national issues. Indeed, when more recently Khrushchev repeated the assertion, reports of his speech indicated not that he was apparently correct but that this was a typical Soviet claim. Second, if social scientists are to concern themselves with offering advice and evaluating national policies, then some means must be found by which they are given at least that information which the community of physical scientists has acquired.

Suggestions for the regular transmission of such information certainly seem in order.

HARVEY SACKS

Department of Sociology,
University of California, Berkeley

DAVID ZIPSER

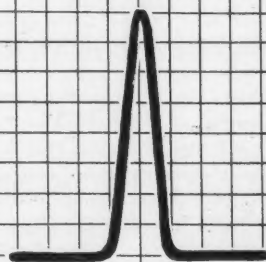
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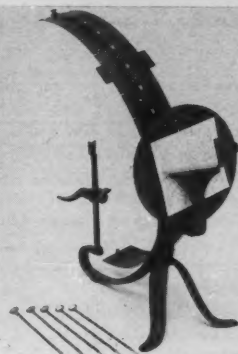
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33rd Sessions International Statistical Institute
Paris, August 29-September 7, 1961

Program Organizer—Joseph Berkson, M.D., D.Sc.
E. Cuyler Hammond, Sc.D., Director Statistical
Research Section, American Cancer Society

*Review of findings in the chief prospective studies
on smoking in relation to health*

Geoffrey Dean, M.D., M.R.C.P., Port Elizabeth,
Union of South Africa

*Comparative mortality from cancer and other
diseases among immigrant and native born whites,
in relation to prevalence of smoking*

Joseph Berkson, M.D., D.Sc., Chief, Division of
Biometry, Mayo Clinic, Rochester, Minnesota

*Difficulty of interpretation of the "association" of
death rates and physical factors*

Harold L. Stewart, M.D., National Cancer
Institute, Washington, D.C.

Experimental investigations of tobacco and cancer

Diego de Castro, Professor, Istituto di Statistica,
Universita di Torino, Turin, Italy

Contributed paper—discussion

Siegfried Koller, Ph.D., Dr. Med., Statistisches
Bundesamt, Wiesbaden, Germany

Contributed paper—discussion

Nonmembers of the I.S.I. wishing to present dis-
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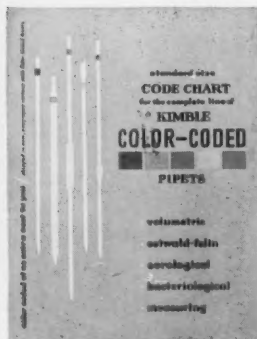
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